Fastener Tightening Specifications (L76)

Application	Specification	
	Metric	English
Active Fuel Management Oil Pressure Relief Valve	27 N·m	20 lb ft
Camshaft Position (CMP) Sensor Bolt	12 N·m	106 lb in
CMP Sensor Wire Harness Bolt	12 N·m	106 lb in
Camshaft Retainer Bolts - TORX® Head Bolts	15 N·m	11 lb ft
Camshaft Sprocket Bolt - First Pass	75 N·m	55 lb ft
Camshaft Sprocket Bolt - Final Pass	50 degrees	
Connecting Rod Bolts - First Pass	20 N·m	15 lb ft
Connecting Rod Bolts - Final Pass	85 degrees	
Coolant Air Bleed Pipe and Cover Bolts	12 N·m	106 lb in
Coolant Temperature Sensor	20 N·m	15 lb ft
Crankshaft Balancer Bolt - First Pass	150 N·m	110 lb ft
Crankshaft Balancer Bolt - Second Pass	Loosen 360 degrees	
Crankshaft Balancer Bolt - Third Pass	50 N·m	37 lb ft
Crankshaft Balancer Bolt - Final Pass	230 degrees	
Crankshaft Bearing Cap M8 Bolts	25 N·m	18 lb ft
Crankshaft Bearing Cap M10 Bolts - First Pass in Sequence	20 N·m	15 lb ft
Crankshaft Bearing Cap M10 Bolts - Final Pass in Sequence	80 degrees	
Crankshaft Bearing Cap M10 Studs - First Pass in Sequence	20 N·m	15 lb ft
Crankshaft Bearing Cap M10 Studs - Final Pass in Sequence	51 degrees	
Crankshaft Oil Deflector Nuts	25 N·m	18 lb ft
Crankshaft Position (CKP) Sensor Bolt	25 N·m	18 lb ft
Crankshaft Rear Oil Seal Housing Bolts	30 N·m	22 lb ft
Cylinder Head Coolant Plug	20 N·m	15 lb ft
Cylinder Head M8 Bolts - in Sequence	30 N·m	22 lb ft
Cylinder Head M11 Bolts - First Pass in Sequence	30 N·m	22 lb ft
Cylinder Head M11 Bolts - Second Pass in Sequence	90 degrees	
Cylinder Head M11 Bolts - Final Pass in Sequence	70 degrees	
Engine Block Coolant Drain Hole Plug	60 N·m	44 lb ft
Engine Block Coolant Heater	50 N·m	37 lb ft
Engine Block Oil Gallery Plug	60 N·m	44 lb ft
Evaporative Emission (EVAP) Canister Purge Solenoid Valve Bolt	50 N·m	37 lb ft
Exhaust Manifold Bolts - First Pass	15 N·m	11 lb ft
Exhaust Manifold Bolts - Final Pass	20 N·m	15 lb ft
Exhaust Manifold Heat Shield Bolts	9 N·m	80 lb in
Exhaust Manifold Studs	20 N·m	15 lb ft

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Flex Plate Bolts - First Pass	20 N·m	15 lb ft
Flex Plate Bolts - Second Pass	50 N·m	37 lb ft
Flex Plate Bolts - Final Pass	100 N·m	74 lb ft
Front Cover Bolt	25 N·m	18 lb ft
Fuel Injection Fuel Rail Bolts	10 N·m	89 lb in
Ignition Coil Bracket-to-Valve Rocker Arm Cover Studs	12 N·m	106 lb in
Ignition Coil-to-Bracket Bolts	10 N·m	89 lb in
Intake Manifold Bolts - First Pass in Sequence	5 N·m	44 lb in
Intake Manifold Bolts - Final Pass in Sequence	10 N·m	89 lb in
J 41798 M8 Bolt	25 N·m	18 lb ft
J 41798 M10 Bolts	50 N·m	37 lb ft
Knock Sensor Bolts	20 N·m	15 lb ft
Oil Filter	30 N·m	22 lb ft
Oil Filter Fitting	55 N·m	40 lb ft
Oil Level Indicator Tube Bolt	25 N·m	18 lb ft
Oil Level Sensor	20 N·m	15 lb ft
Oil Pan Baffle Bolt	12 N·m	106 lb in
Oil Pan Closeout Cover Bolt - Left Side	9 N·m	80 lb in
Oil Pan Closeout Cover Bolt - Right Side	9 N·m	80 lb in
Oil Pan Cover Bolts	12 N·m	106 lb in
Oil Pan Drain Plug	25 N·m	18 lb ft
Oil Pan M6 Bolts - Oil Pan-to-Rear Oil Seal Housing	12 N·m	106 lb in
Oil Pan M8 Bolts - Oil Pan-to-Engine Block and Oil Pan-to-Front Cover	25 N·m	18 lb ft
Oil Pressure Sensor	35 N·m	26 lb ft
Oil Pump Cover Bolts	12 N·m	106 lb in
Oil Pump Relief Valve Plug	12 N·m	106 lb in
Oil Pump Screen-to-Oil Pump Bolt	12 N·m	106 lb in
Oil Pump-to-Engine Block Bolts	25 N·m	18 lb ft
Spark Plugs	15 N·m	11 lb ft
Throttle Body Bolts	10 N·m	89 lb in
Timing Chain Tensioner Bolts	25 N·m	18 lb ft
Valve Lifter Oil Manifold Bolts	25 N·m	18 lb ft
Valve Lifter Guide Bolts	10 N·m	89 lb in
Valve Rocker Arm Bolts	30 N·m	22 lb ft
Valve Rocker Arm Cover Bolts	12 N·m	106 lb in
Water Inlet Housing Bolts	15 N·m	11 lb ft
Water Pump Bolts - First Pass	15 N·m	11 lb ft
Water Pump Bolts - Final Pass	30 N·m	22 lb ft

Fastener Tightening Specifications (6.2L LS3)

Application	Specification	
	Metric	English
Active Fuel Management Oil Pressure Relief Valve	27 N·m	20 lb ft
Camshaft Position (CMP) Sensor Bolt	12 N·m	106 lb in
CMP Sensor Wire Harness Bolt	12 N·m	106 lb in
Camshaft Retainer Bolts - Hex Head Bolts	25 N·m	18 lb ft
Camshaft Retainer Bolts - TORX® Head Bolts	15 N·m	11 lb ft
Camshaft Sprocket Bolt - First Pass	75 N·m	55 lb ft
Camshaft Sprocket Bolt - Final Pass	50 degrees	
Clutch Pressure Plate Bolts	70 N·m	52 lb ft
Connecting Rod Bolts - First Pass	20 N·m	15 lb ft
Connecting Rod Bolts - Final Pass	85 degrees	
Coolant Air Bleed Pipe and Cover Bolts	12 N·m	106 lb in
Coolant Temperature Sensor	20 N·m	15 lb ft
Crankshaft Balancer Bolt - First Pass	150 N·m	111 lb ft
Crankshaft Balancer Bolt - Second Pass	Loosen 360 degrees	
Crankshaft Balancer Bolt - Third Pass	50 N·m	37 lb ft
Crankshaft Balancer Bolt - Final Pass	230 degrees	
Crankshaft Bearing Cap M10 Bolts - First Pass in Sequence	20 N·m	15 lb ft
Crankshaft Bearing Cap M10 Bolts - Final Pass in Sequence	80 degrees	
Crankshaft Bearing Cap M10 Studs - First Pass in Sequence	20 N·m	15 lb ft
Crankshaft Bearing Cap M10 Studs - Final Pass in Sequence	51 degrees	
Crankshaft Bearing Cap M8 Bolts	25 N·m	18 lb ft
Crankshaft Oil Deflector Nuts	25 N·m	18 lb ft
Crankshaft Position (CKP) Sensor Bolt	25 N·m	18 lb ft
Crankshaft Rear Oil Seal Housing Bolts	30 N·m	22 lb ft
Cylinder Head M11 Bolts - First Pass in Sequence	30 N·m	22 lb ft
Cylinder Head M11 Bolts - Second Pass in Sequence	90 degrees	
Cylinder Head M11 Bolts - Final Pass in Sequence	70 degrees	
Cylinder Head M8 Bolts - in Sequence	30 N·m	22 lb ft
Cylinder Head Coolant Plug	20 N·m	15 lb ft
Engine Block Coolant Drain Hole Plug	60 N·m	44 lb ft
Engine Block Coolant Heater	50 N·m	37 lb ft
Engine Block Oil Gallery Plug	60 N·m	44 lb ft
Evaporative Emission (EVAP) Canister Purge Solenoid Valve Bolt	50 N·m	37 lb ft
Exhaust Manifold Bolts - First Pass	15 N·m	11 lb ft
Exhaust Manifold Bolts - Final Pass	20 N·m	15 lb ft

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Exhaust Manifold Heat Shield Bolts	9 N·m	80 lb in
Exhaust Manifold Stud	20 N·m	15 lb ft
Flywheel Bolts - First Pass	20 N·m	15 lb ft
Flywheel Bolts - Second Pass	50 N·m	37 lb ft
Flywheel Bolts - Final Pass	100 N·m	74 lb ft
Front Cover Bolts	25 N·m	18 lb ft
Fuel Injection Fuel Rail Bolts	10 N·m	89 lb in
Ignition Coil Bracket-to-Valve Rocker Arm Cover Stud	12 N·m	106 lb in
Ignition Coil-to-Bracket Bolts	10 N·m	89 lb in
Intake Manifold Bolts - First Pass in Sequence	5 N·m	44 lb in
Intake Manifold Bolts - Final Pass in Sequence	10 N·m	89 lb in
J 41798 M8 Bolt	25 N·m	18 lb ft
J 41798 M10 Bolts	50 N·m	37 lb ft
Knock Sensor Bolts	20 N·m	15 lb ft
Motor Mount Bracket Bolts	50 N·m	37 lb ft
Oil Filter	30 N·m	22 lb ft
Oil Filter Fitting	55 N·m	40 lb ft
Oil Level Indicator Tube Bolt	25 N·m	18 lb ft
Oil Level Sensor	13 N·m	115 lb in
Oil Pan Closeout Cover Bolt - Left Side	9 N·m	80 lb in
Oil Pan Closeout Cover Bolt - Right Side	9 N·m	80 lb in
Oil Pan Cover Bolts	12 N·m	106 lb in
Oil Pan Drain Plug	25 N·m	18 lb ft
Oil Pan M6 Bolts - Oil Pan-to-Rear Oil Seal Housing	12 N·m	106 lb in
Oil Pan M8 Bolts - Oil Pan-to-Engine Block and Oil Pan-to-Front Cover	25 N·m	18 lb ft
Oil Pressure Sensor	35 N·m	26 lb ft
Oil Pump Cover Bolts	12 N·m	106 lb in
Oil Pump Relief Valve Plug	12 N·m	106 lb in
Oil Pump Screen Nuts	25 N·m	18 lb ft
Oil Pump Screen-to-Oil Pump Bolt	12 N·m	106 lb in
Oil Pump-to-Engine Block Bolts	25 N·m	18 lb ft
Spark Plugs	15 N·m	11 lb ft
Throttle Body Bolts	10 N·m	89 lb in
Timing Chain Tensioner Bolts	25 N·m	18 lb ft
Valley Cover Bolts	25 N·m	18 lb ft
Valve Lifter Guide Bolts	12 N·m	106 lb in
Valve Rocker Arm Bolts	30 N·m	22 lb ft
Valve Rocker Arm Cover Bolts	12 N·m	106 lb in
Water Inlet Housing Bolts	15 N·m	11 lb ft
Water Pump Bolts - First Pass	15 N·m	11 lb ft

Water Pump Bolts - Final Pass	30 N·m	22 lb ft

Engine Mechanical Specifications (L76)

Application	Specification	
	Metric	English
Engine Type	V8	
Displacement	5697 cu cm	348 cu in
RPO	L76	
Bore	101.618-101.636 mm	4.0007-4.0017 in
Stroke	92.0 mm	3.622 in
Compression Ratio	9.67:1	
Firing Order	1-8-7-2-6-5-4-3	
Active Fuel Management Cylinders	1-4-6-7	
Spark Plug Gap	1.02 mm	0.04 in
Block		
Camshaft Bearing Bore 1 and 5 Diameter	59.58-59.63 mm	2.345-2.347 in
Camshaft Bearing Bore 2 and 4 Diameter	59.08-59.13 mm	2.325-2.327 in
Camshaft Bearing Bore 3 Diameter	58.58-58.63 mm	2.306-2.308 in
Crankshaft Main Bearing Bore Diameter	69.871-69.889 mm	2.75-2.751 in
Crankshaft Main Bearing Bore Out-of-Round	0.006 mm	0.0002 in
Cylinder Bore Diameter	101.618-101.636 mm	4.0007-4.0017 in
Cylinder Head Deck Height - Measuring from the Centerline of Crankshaft to the Deck Face	234.57-234.82 mm	9.235-9.245 in
Cylinder Head Deck Surface Flatness - Measured Within a 152.4 mm (6.0 in) Area	0.11 mm	0.004 in
Cylinder Head Deck Surface Flatness - Measuring the Overall Length of the Block Deck	0.22 mm	0.008 in
Valve Lifter Bore Diameter	21.417-21.443 mm	0.843-0.844 in
Camshaft		
Camshaft End Play	0.025-0.305 mm	0.001-0.012 in
Camshaft Journal Diameter	54.99-55.04 mm	2.164-2.166 in
Camshaft Journal Out-of-Round	0.025 mm	0.001 in
Camshaft Lobe Lift - Exhaust - Non Active Fuel Management Cylinders	7.17 mm	0.282 in
Camshaft Lobe Lift - Exhaust - Active Fuel Management Cylinders	7.3 mm	0.287 in

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Camshaft Lobe Lift - Intake - Non Active Fuel Management Cylinders	7.08 mm	0.279 in
Camshaft Lobe Lift - Intake - Active Fuel Management Cylinders	7.2 mm	0.283 in
Camshaft Runout - Measured at the Intermediate Journals	0.05 mm	0.002 in
Connecting Rod		
Connecting Rod Bearing Clearance - Production	0.023-0.065 mm	0.0009-0.0025 in
Connecting Rod Bearing Clearance - Service	0.023-0.076 mm	0.0009-0.003 in
Connecting Rod Bore Diameter - Bearing End	56.505-56.525 mm	2.224-2.225 in
Connecting Rod Bore Out-of-Round - Bearing End - Production	0.004-0.008 mm	0.00015-0.0003 in
Connecting Rod Bore Out-of-Round - Bearing End - Service	0.004-0.008 mm	0.00015-0.0003 in
Connecting Rod Side Clearance	0.11-0.51 mm	0.00433-0.02 in
Crankshaft		
Connecting Rod Journal Diameter - Production	53.318 mm 53.338 mm	2.0991 in 2.0999 in
Connecting Rod Journal Diameter - Service	53.308 mm	2.0987 in
Connecting Rod Journal Out - of - Round - Production	0.005 mm	0.0002 in
Connecting Rod Journal Out - of - Round - Service	0.01 mm	0.0004 in
Connecting Rod Journal Taper (Maximum for 1/2 of Journal Length - Production)	0.005 mm	0.0002 in
Connecting Rod Journal Taper (Maximum for 1/2 of Journal Length - Service)	0.02 mm	0.00078 in
Crankshaft End Play	0.04 mm 0.2 mm	0.0015 in 0.0078 in
Crankshaft Main Bearing Clearance - Production	0.02 mm 0.052 mm	0.0008 in 0.0021 in
Crankshaft Main Bearing Clearance - Service	0.02 mm 0.065 mm	0.0008 in 0.0025 in
Crankshaft Main Journal Diameter - Production	64.992 mm 65.008 mm	2.558 in 2.559 in
Crankshaft Main Journal Diameter - Service	64.992 mm	2.558 in
Crankshaft Main Journal Out - of - Round - Production	0.003 mm	0.000118 in
Crankshaft Main Journal Out - of - Round - Service	0.008 mm	0.0003 in

Crankshaft Main Journal Taper - Production	0.01 mm	0.0004 in
Crankshaft Main Journal Taper - Service	0.02 mm	0.00078 in
Crankshaft Rear Flange Runout	0.05 mm	0.002 in
Crankshaft Reluctor Ring Runout (Measured 1.0 mm (0.04 in) Below Tooth Diameter)	0.7 mm	0.028 in
Crankshaft Thrust Surface - Production	26.14 mm 26.22 mm	1.029 in 1.0315 in
Crankshaft Thrust Surface - Service	26.22 mm	1.0315 in
Crankshaft Thrust Surface Runout	0.025 mm	0.001 in
Cylinder Head		
Cylinder Head Height/Thickness (Measured from the Cylinder Head Deck to the Valve Rocker Arm Cover Seal Surface)	120.2 mm	4.732 in
Surface Flatness - Block Deck (Measured within a 152.4 mm (6.0 in) Area)	0.08 mm	0.003 in
Surface Flatness - Block Deck (Measuring the Overall Length of the Cylinder Head)	0.1 mm	0.004 in
Surface Flatness - Exhaust Manifold Deck	0.13 mm	0.005 in
Surface Flatness - Intake Manifold Deck	0.08 mm	0.0031 in
Valve Guide Installed Height (Measured from the Spring Seat Surface to the Top of the Guide)	17.32 mm	0.682 in
Intake Manifold		
Surface Flatness (Measured at Gasket Sealing Surfaces and Measured Within a 200 mm (7.87 in) Area that Includes 2 Runner Port Openings)	0.3 mm	0.118 in
Lubrication System		
Oil Capacity - with Filter	8.3 Litres	8.8 Quarts
Oil Pressure - Minimum - Hot	41 kPa at 1,000 engine RPM 124 kPa at 2,000 engine RPM 165 kPa at 4,000 engine RPM	6 psig at 1,000 engine RPM 18 psig at 2,000 engine RPM 24 psig at 4,000 engine RPM
Active Fuel Management Relief	379-517 kPa	55-75 psi

Valve Oil Pressure - as Measured at Oil Pressure Sensor Location	Maximum	Maximum
Oil Pan		
Front Cover Alignment - at Oil Pan Surface	0.0 mm 0.5 mm	0.0 in 0.02 in
Crankshaft Rear Oil Seal Housing Alignment - at Oil Pan Surface	0.0 mm 0.5 mm	0.0 in 0.02 in
Oil Pan Alignment - to Rear of Engine Block at Transmission Bell Housing Mounting Surface	0.0 mm 0.1 mm	0.0 in 0.004 in
Piston Rings		
Piston Ring End Gap - First Compression Ring (Measured in Cylinder Bore - Production)	0.20 mm 0.41 mm	0.008 in 0.016 in
Piston Ring End Gap - First Compression Ring (Measured in Cylinder Bore - Service)	0.20 mm 0.41 mm	0.008 in 0.016 in
Piston Ring End Gap - Second Compression Ring (Measured in Cylinder Bore - Production)	0.37 mm 0.69 mm	0.015 in 0.027 in
Piston Ring End Gap - Second Compression Ring (Measured in Cylinder Bore - Service)	0.37 mm 0.69 mm	0.015 in 0.027 in
Piston Ring End Gap - Oil Control Ring (Measured in Cylinder Bore - Production)	0.22 mm 0.79 mm	0.009 in 0.031 in
Piston Ring End Gap - Oil Control Ring (Measured in Cylinder Bore - Service)	0.22 mm 0.79 mm	0.009 in 0.031 in
Piston Ring to Groove Clearance - First Compression Ring - Production	0.030 mm 0.10 mm	0.0012 in 0.0040 in
Piston Ring to Groove Clearance - First Compression Ring - Service	0.030 mm 0.10 mm	0.0012 in 0.0040 in
Piston Ring to Groove Clearance - Second Compression Ring - Production	0.035 mm 0.078 mm	0.0014 in 0.0031 in
Piston Ring to Groove Clearance - Second Compression Ring - Service	0.035 mm 0.078 mm	0.0014 in 0.0031 in
Piston Ring to Groove Clearance - Oil Control Ring - Production	0.013 mm 0.201 mm	0.0005 in 0.0079 in
Piston Ring to Groove Clearance - Oil Control Ring - Service	0.013 mm 0.201 mm	0.0005 in 0.0079 in
Pistons and Pins		
Pin - Piston Pin Clearance to Piston Pin Bore - Production	0.002 mm 0.01 mm	0.0008 in 0.0004 in
Pin - Piston Pin Clearance to Piston		

Pin Bore - Service	0.002 mm 0.015 mm	0.0008 in 0.0006 in
Pin - Piston Pin Diameter	23.952 mm 23.955 mm	0.943 in 0.943 in
Pin - Piston Pin Fit in Connecting Rod Bore - Production	0.007 mm 0.02 mm	0.00027 in 0.00078 in
Pin - Piston Pin Fit in Connecting Rod Bore - Service	0.007 mm 0.022 mm	0.00027 in 0.00086 in
Piston - Piston Diameter - Measured Over Skirt Coating	101.611 mm 101.642 mm	4.0 in 4.001 in
Piston - Piston to Bore Clearance - Production	-0.022 mm 0.08 mm	-0.0009 in 0.0012 in
Piston - Piston to Bore Clearance (Service Limit with Skirt Coating Worn Off)	0.024 mm 0.08 mm	0.00094 in 0.0031 in
Valve System		
Valves - Valve Face Angle	45 degrees	
Valves - Valve Face Width	1.25 mm	0.05 in
Valves - Valve Lash	Net Lash - No Adjustment	
Valve Lift - Exhaust - Non Active Fuel Management	12.19 mm	0.480 in
Valve Lift - Exhaust - Active Fuel Management	12.41 mm	0.489 in
Valve Lift - Intake - Non Active Fuel Management	12.04 mm	0.474 in
Valve Lift - Intake - Active Fuel Management	12.24 mm	0.488 in
Valves - Valve Seat Angle	46 degrees	
Valves - Valve Seat Runout	0.05 mm	0.002 in
Valves - Valve Seat Width - Exhaust	1.78 mm	0.07 in
Valves - Valve Seat Width - Intake	1.02 mm	0.04 in
Valves - Valve Stem Diameter - Production	7.955-7.976 mm	0.313-0.314 in
Valves - Valve Stem Diameter - Service	7.95 mm	0.313 in
Valves - Valve Stem-to-Guide Clearance - Production - Exhaust	0.025-0.066 mm	0.001-0.0026 in
Valves - Valve Stem-to-Guide Clearance - Service - Exhaust	0.093 mm	0.0037 in
Valves - Valve Stem-to-Guide Clearance - Production - Intake	0.025-0.066 mm	0.001-0.0026 in
Valves - Valve Stem-to-Guide Clearance - Service - Intake	0.093 mm	0.0037 in
Rocker Arms - Valve Rocker Arm Ratio	1.70:1	
Valve Springs - Valve Spring Free Length	52.9 mm	2.08 in

Valve Springs - Valve Spring Installed Height	45.75 mm	1.8 in
Valve Springs - Valve Spring Load - Closed	340 N at 45.75 mm	76 lb at 1.8 in
Valve Springs - Valve Spring Load - Open	980 N at 33.55 mm	220 lb at 1.32 in

Engine Mechanical Specifications (6.2L LS3)

Application	Specification	
	Metric	English
General		
Engine Type	V8	
Displacement	6.2L	376 CID
RPO	LS3	
VIN	W	
Bore	103.241-103.259 mm	4.0065-4.0065 in
Stroke	92.0 mm	3.622 in
Compression Ratio	10.7:1	
Firing Order	1-8-7-2-6-5-4-3	
Spark Plug Gap	1.02 mm	0.04 in
Block		
Camshaft Bearing Bore 1 and 5 Diameter	59.58-59.63 mm	2.345-2.347 in
Camshaft Bearing Bore 2 and 4 Diameter	59.08-59.13 mm	2.325-2.327 in
Camshaft Bearing Bore 3 Diameter	58.58-58.63 mm	2.306-2.308 in
Crankshaft Main Bearing Bore Diameter	69.871-69.889 mm	2.75-2.751 in
Crankshaft Main Bearing Bore Out-of-Round	0.006 mm	0.0002 in
Cylinder Bore Diameter	103.241-103.259 mm	4.0065-4.0065 in
Cylinder Head Deck Height - Measuring from the Centerline of Crankshaft to the Deck Face	234.57-234.82 mm	9.235-9.245 in
Cylinder Head Deck Surface Flatness - Measured within a 152.4 mm (6.0 in) Area	0.11 mm	0.004 in
Cylinder Head Deck Surface Flatness - Measuring the Overall Length of the Block Deck	0.22 mm	0.008 in
Valve Lifter Bore Diameter	21.417-21.443 mm	0.843-0.844 in
Camshaft		
Camshaft End Play	0.025-0.305 mm	0.001-0.012 in
Camshaft Journal Diameter	54.99-55.04 mm	2.164-2.166 in
Camshaft Bearing Diameter	55.063-55.088 mm	2.1678-2.1688 in
Camshaft Journal-to-Bearing Clearance	0.023-0.098 mm	0.0009-0.0038 in
Camshaft Journal Out-of-Round	0.025 mm	0.001 in
Camshaft Lobe Lift - Intake	8.24 mm	0.324 in

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Camshaft Lobe Lift - Exhaust	7.77 mm	0.306 in
Camshaft Runout - Measured at the Intermediate Journals	0.05 mm	0.002 in
Connecting Rod		
Connecting Rod Bearing Clearance - Production	0.023-0.065 mm	0.0009-0.0025 in
Connecting Rod Bearing Clearance - Service	0.023-0.076 mm	0.0009-0.003 in
Connecting Rod Bore Diameter - Bearing End	56.505-56.525 mm	2.224-2.225 in
Connecting Rod Bore Out-of-Round - Bearing End - Production	0.004-0.008 mm	0.00015-0.0003 in
Connecting Rod Bore Out-of-Round - Bearing End - Service	0.004-0.008 mm	0.00015-0.0003 in
Connecting Rod Side Clearance	0.11-0.51 mm	0.00433-0.02 in
Crankshaft		
Connecting Rod Journal Diameter - Production	53.318-53.338 mm	2.0991-2.0999 in
Connecting Rod Journal Diameter - Service	53.308 mm	2.0987 in
Connecting Rod Journal Out-of-Round - Production	0.005 mm	0.0002 in
Connecting Rod Journal Out-of-Round - Service	0.01 mm	0.0004 in
Connecting Rod Journal Taper - Maximum for 1/2 of Journal Length - Production	0.005 mm	0.0002 in
Connecting Rod Journal Taper - Maximum for 1/2 of Journal Length - Service	0.02 mm	0.00078 in
Crankshaft End Play	0.04-0.2 mm	0.0015-0.0078 in
Crankshaft Main Bearing Clearance - Production	0.02-0.052 mm	0.0008-0.0021 in
Crankshaft Main Bearing Clearance - Service	0.02-0.065 mm	0.0008-0.0025 in
Crankshaft Main Journal Diameter - Production	64.992-65.008 mm	2.558-2.559 in
Crankshaft Main Journal Diameter - Service	64.992 mm	2.558 in
Crankshaft Main Journal Out-of-Round - Production	0.003 mm	0.000118 in
Crankshaft Main Journal Out-of-Round - Service	0.008 mm	0.0003 in
Crankshaft Main Journal Taper - Production	0.01 mm	0.0004 in
Crankshaft Main Journal Taper - Service	0.02 mm	0.00078 in
Crankshaft Rear Flange Runout	0.05 mm	0.002 in
Crankshaft Reluctor Ring Runout - Measured 1.0 mm (0.04 in) Below Tooth Diameter	0.7 mm	0.028 in
Crankshaft Thrust Surface - Production	26.14-26.22 mm	1.029-1.0315 in
Crankshaft Thrust Surface - Service	26.22 mm	1.0315 in
Crankshaft Thrust Surface Runout	0.025 mm	0.001 in
Cylinder Head		

Cylinder Head Height/Thickness - Measured from the Cylinder Head Deck to the Valve Rocker Arm Cover Seal Surface	120.2 mm	4.732 in
Surface Flatness - Block Deck - Measured within a 152.4 mm (6.0 in) Area	0.08 mm	0.003 in
Surface Flatness - Block Deck - Measuring the Overall Length of the Cylinder Head	0.1 mm	0.004 in
Surface Flatness - Exhaust Manifold Deck	0.13 mm	0.005 in
Surface Flatness - Intake Manifold Deck	0.08 mm	0.0031 in
Valve Guide Installed Height - Measured from the Spring Seat Surface to the Top of the Guide	17.32 mm	0.682 in
Intake Manifold		
Surface Flatness - Measured at Gasket Sealing Surfaces and Measured Within a 200 mm (7.87 in) Area that Includes 2 Runner Port Openings	0.3 mm	0.118 in
Lubrication System		
Oil Capacity - with Filter	8.3 liters	8.8 quarts
Oil Capacity - without Filter	5.4 liters	5.7 quarts
Oil Pressure - Minimum - Hot	41 kPa at 1,000 engine RPM 124 kPa at 2,000 engine RPM 165 kPa at 4,000 engine RPM	6 psig at 1,000 engine RPM 18 psig at 2,000 engine RPM 24 psig at 4,000 engine RPM
Oil Pan		
Front Cover Alignment - at Oil Pan Surface	0.0-0.5 mm	0.0-0.02 in
Crankshaft Rear Oil Seal Housing Alignment - at Oil Pan Surface	0.0-0.5 mm	0.0-0.02 in
Oil Pan Alignment - to Rear of Engine Block at Transmission Bell Housing Mounting Surface	0.0-0.1 mm	0.0-0.004 in
Piston Rings		
Piston Ring End Gap - First Compression Ring - Measured in Cylinder Bore - Production	0.17-0.38 mm	0.0067-0.0150 in
Piston Ring End Gap - First Compression Ring - Measured in Cylinder Bore - Service	0.17-0.44 mm	0.0067-0.0173 in
Piston Ring End Gap - Second Compression Ring - Measured in Cylinder Bore - Production	0.32-0.63 mm	0.0126-0.0248 in
Piston Ring End Gap - Second Compression Ring - Measured in Cylinder Bore - Service	0.32-0.69 mm	0.0126-0.0272 in
Piston Ring End Gap - Oil Control Ring - Measured in Cylinder Bore - Production	0.22-0.79 mm	0.0086-0.0311 in
Piston Ring End Gap - Oil Control Ring - Measured in Cylinder Bore - Service	0.22-0.85 mm	0.0086-0.0335 in
Piston Ring to Groove Clearance - First	0.030-0.083 mm	0.0012-

Compression Ring - Production		0.0033 in
Piston Ring to Groove Clearance - First Compression Ring - Service	0.030-0.083 mm	0.0012-0.0033 in
Piston Ring to Groove Clearance - Second Compression Ring - Production	0.040-0.083 mm	0.0016-0.0033 in
Piston Ring to Groove Clearance - Second Compression Ring - Service	0.040-0.083 mm	0.0016-0.0033 in
Piston Ring to Groove Clearance - Oil Control Ring - Production	0.013-0.201 mm	0.0005-0.0079 in
Piston Ring to Groove Clearance - Oil Control Ring - Service	0.013-0.201 mm	0.0005-0.0079 in
Pistons and Pins		
Pin - Piston Pin Clearance to Piston Pin Bore - Production	0.002-0.01 mm	0.00008-0.0004 in
Pin - Piston Pin Clearance to Piston Pin Bore - Service	0.002-0.015 mm	0.00008-0.0006 in
Pin - Piston Pin Diameter	23.952-23.955 mm	0.9430-0.9431 in
Pin - Piston Pin Fit in Connecting Rod Bore - Production	0.007-0.02 mm	0.00027-0.00078 in
Pin - Piston Pin Fit in Connecting Rod Bore - Service	0.007-0.022 mm	0.00027-0.00086 in
Piston - Piston Diameter - Measured Over Skirt Coating	103.258-103.289 mm	4.0653-4.0665 in
Piston - Piston to Bore Clearance - Production	-0.048 to +0.001 mm	-0.0019 to +0.000 in
Piston - Piston to Bore Clearance - Service Limit with Skirt Coating Worn Off	0.055 mm	0.0022 in
Valve System		
Valves - Valve Face Angle	45 degrees	
Valves - Valve Face Width	1.25 mm	0.05 in
Valves - Valve Lash	Net Lash - No Adjustment	
Valves - Valve Lift - Intake	13.97 mm	0.55 in
Valves - Valve Lift - Exhaust	13.22 mm	0.52 in
Valves - Valve Seat Angle	46 degrees	
Valves - Valve Seat Runout	0.05 mm	0.002 in
Valves - Valve Seat Width - Exhaust	1.78 mm	0.07 in
Valves - Seat Width - Intake	1.02 mm	0.04 in
Valves - Valve Stem Diameter - Production	7.955-7.976 mm	0.313-0.314 in
Valves - Valve Stem Diameter - Service	7.95 mm	0.313 in
Valves - Valve Stem-to-Guide Clearance - Production - Intake	0.025-0.066 mm	0.001-0.0026 in
Valves - Valve Stem-to-Guide Clearance - Service - Intake	0.093 mm	0.0037 in

Valves - Valve Stem-to-Guide Clearance - Production - Exhaust	0.025-0.066 mm	0.001-0.0026 in
Valves - Valve Stem-to-Guide Clearance - Service - Exhaust	0.093 mm	0.0037 in
Rocker Arms - Valve Rocker Arm Ratio	1.70:1	
Valve Springs - Valve Spring Free Length	52.9 mm	2.08 in
Valve Springs - Valve Spring Installed Height	45.75 mm	1.8 in
Valve Springs - Valve Spring Load - Closed	400 N at 45.75 mm	90 lb at 1.8 in
Valve Springs - Valve Spring Load - Open	1175 N at 33.05 mm	264 lb at 1.30 in

Engine Content Specifications

RPO	VIN	Displacement	Camshaft Position (CMP) Actuator Control System	Active Fuel Management Control System	E85 Capable	Block Material
L76	Y	6.0L	No	Yes	No	Aluminum
LS3	W	6.2L	No	No	No	Aluminum

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Adhesives, Fluids, Lubricants, and Sealers

Application	Type of Material	GM Part Number	
		United States	Canada
Coolant Temperature Sensor Threads	Sealant	12346004	10953480
Cylinder Head Core Hole Plugs	Threadlock	12345382	10953489
Cylinder Head Plug	Threadlock	12345382	10953489
Engine Block Coolant Drain Hole Plug Washer	Sealant	12346004	10953480
Engine Block Oil Gallery Plug - Front	Threadlock	12345382	10953489
Engine Block Oil Gallery Plug Washers	Sealant	12346004	10953480
Engine Oil	5W-30 Oil	12345610	729389
Engine Oil Pressure Sensor Threads	Sealant	12346004	10953480
Engine Oil Supplement	Fluorescent Dye	12345795	10953470
Exhaust Manifold Bolts	Threadlock	12345493	10953488
Flexplate/Flywheel Bolts	Threadlock	12345382	10953489
Fuel Injection Fuel Rail Bolts	Threadlock	12345382	10953489
Ignition Coil Bracket-to-Valve Cover Studs	Threadlock	12345382	10953489
Ignition Coil-to-Bracket Bolts	Threadlock	12345382	10953489
Intake Manifold Bolts	Threadlock	12345382	10953489
Oil Pan Surface at Front Cover and Rear Housing	Sealant	12378521	88901148
Thread Repair Component Cleaner	Cleaner	12346139	10953463
Thread Repair Component Cleaner	Cleaner	12377981	10953463
Thread Repair Cutting Oil	Lubricant	1052864	992881

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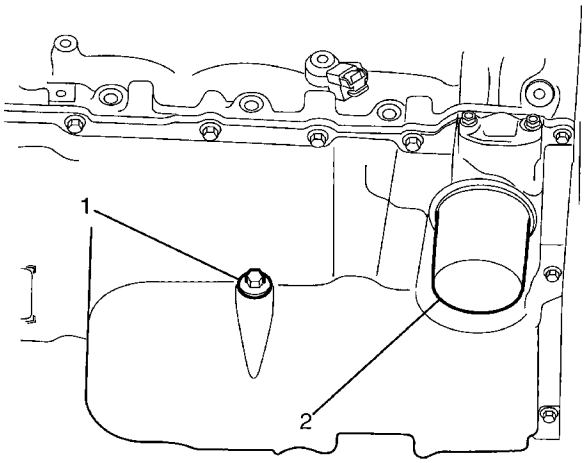
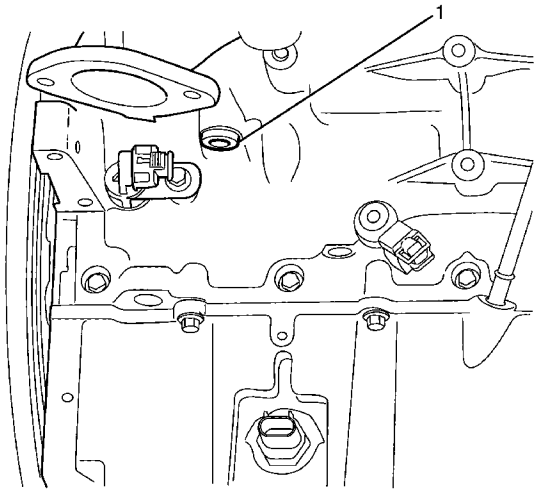
Draining Fluids and Oil Filter Removal



1. Remove the oil pan drain plug (1).
2. Drain the engine oil into an appropriate container.
3. Remove the engine oil filter (2).



4. Remove the right side rear engine block coolant drain hole plug and washer (1).

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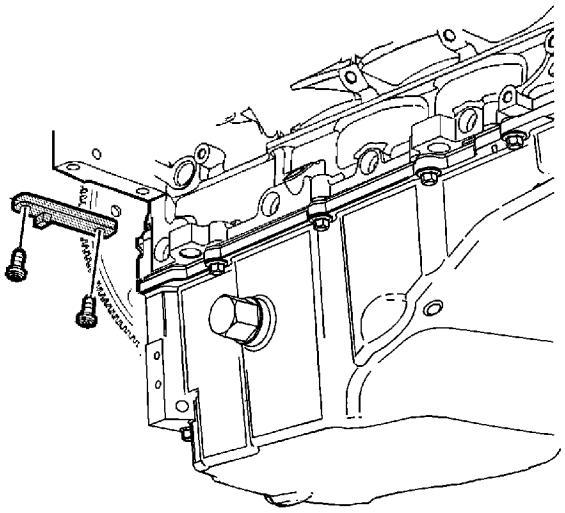
Crankshaft Balancer Removal (6.2L LS3)

Special Tools

- *J 41816-A* Crankshaft Balancer Remover
- *J 41816-2* Crankshaft End Protector
- *J 42386-A* Flywheel Holding Tool

For equivalent regional tools, refer to Special Tools.

Caution: Refer to Fastener Caution in the Preface section.



Note: Do not use the crankshaft balancer bolt again. Install a NEW crankshaft balancer bolt during final assembly.

1. Install the *J 42386-A* holding tool and bolts.

   Use 1 M10 - 1.5 x 120 mm and 1 M10 - 1.5 x 45 mm bolt for proper tool operation. Tighten the *J 42386-A* holding tool bolts to **50 N·m (37 lb ft)**.

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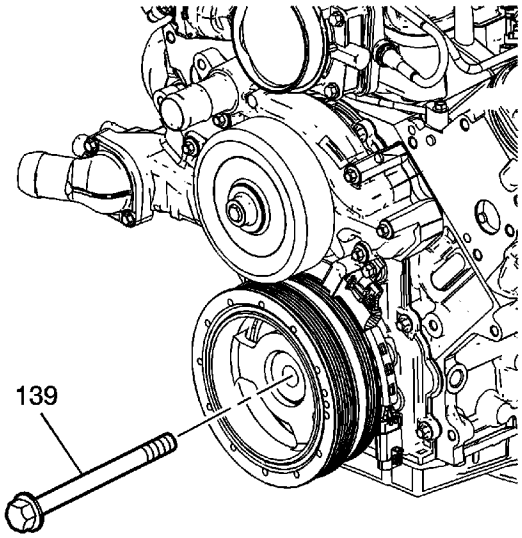
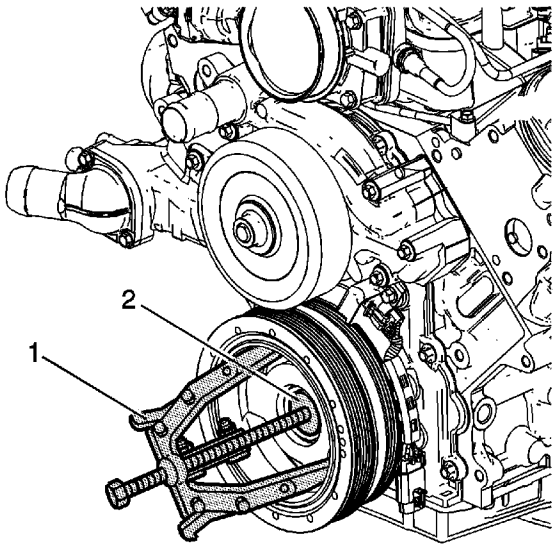
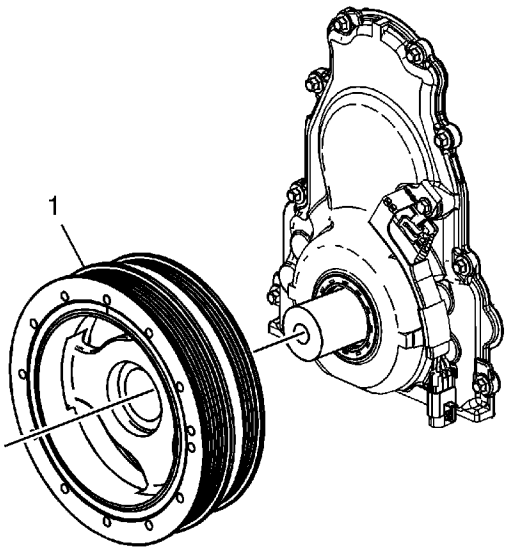


2. Remove the crankshaft balancer bolt (139).

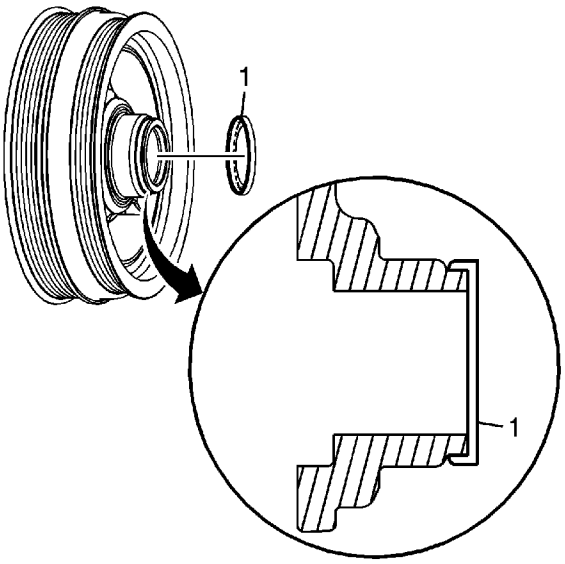
   Do not discard the crankshaft balancer bolt. The balancer bolt will be used during the balancer installation procedure.



3. Use the *J 41816-A* remover (1) and the *J 41816-2* protector (2) in order to remove the crankshaft balancer.



4. Remove the crankshaft balancer (1).



5. Remove the crankshaft balancer washer (1) from the LS3 balancer as required.

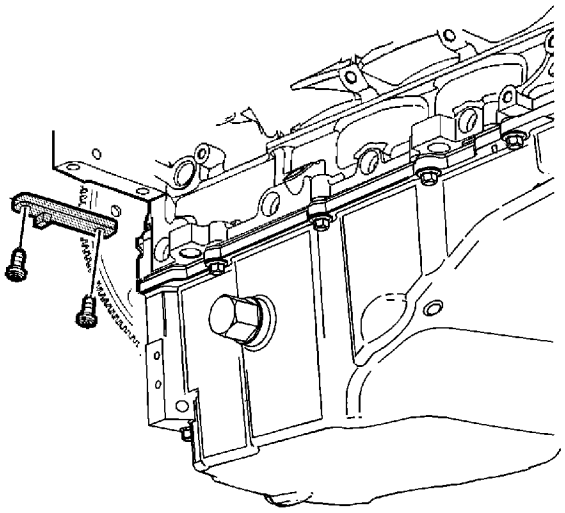
Crankshaft Balancer Removal (L76)

Special Tools

- *J 41816* Crankshaft Balancer Remover
- *J 41816-2* Crankshaft End Protector
- *J 42386-A* Flywheel Holding Tool

For equivalent regional tools, refer to Special Tools.

Caution: Refer to Fastener Caution in the Preface section.



Note: Do not use the crankshaft balancer bolt again. Install a NEW crankshaft balancer bolt during final assembly.

1. Install the *J 42386-A* holding tool and bolts.

   Use one M10 - 1.5 x 120 mm and one M10 - 1.5 x 45 mm bolt for proper tool operation. Tighten the *J 42386-A* holding tool bolts to **50 N·m (37 lb ft)**.

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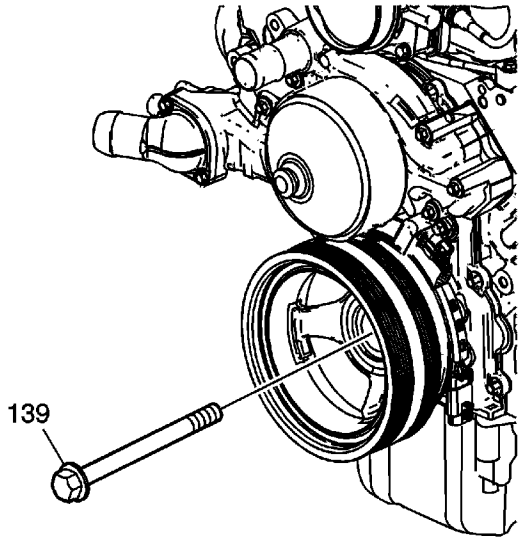
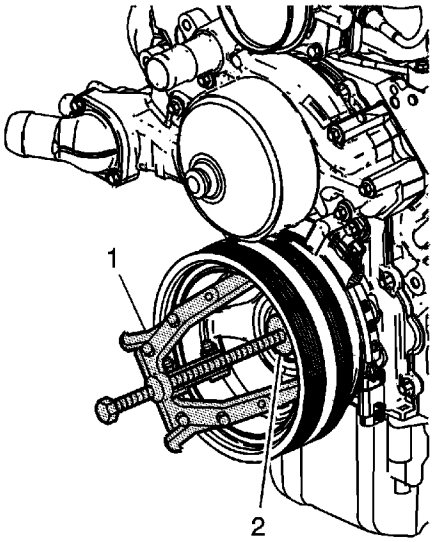
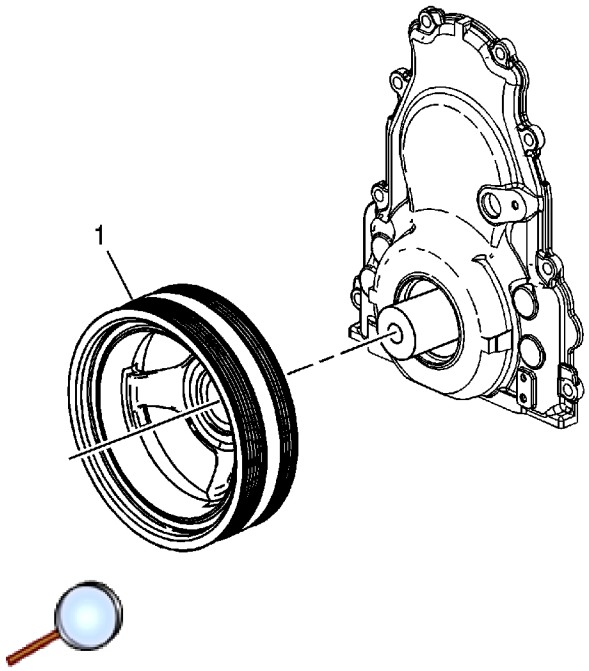


2. Remove the crankshaft balancer bolt (139).

   Do not discard the crankshaft balancer bolt. The balancer bolt will be used during the balancer installation procedure.

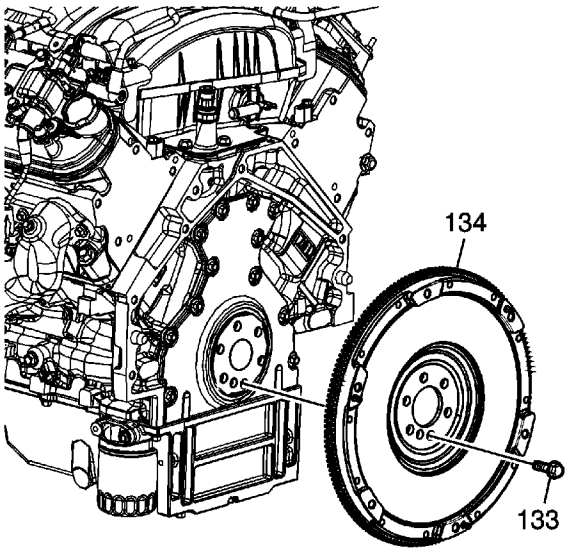


3. Use the *J 41816* remover (1) and the *J 41816-2* protector (2) in order to remove the crankshaft balancer.



4. Remove the crankshaft balancer (138).
5. Remove the *J 42386-A* holding tool and bolts.

Engine Flywheel Removal



1. Remove the flywheel bolts (133).
2. Remove the manual transmission flywheel (134).

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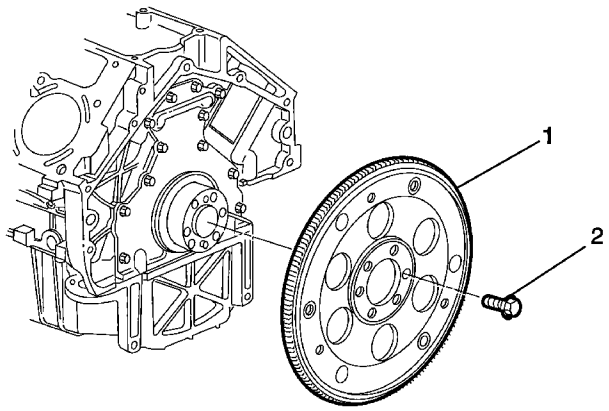
Automatic Transmission Flex Plate Removal

Removal Procedure



Important: Note the position and direction of the flexplate (1) before removal. The flexplate (1) does not use a locating pin for alignment. Mark or scribe the end of the crankshaft and the flexplate (1) before component removal.

Important: The flexplate retaining bolts (2) are single use components only. The flexplate retaining bolts (2) must be replaced upon removal

1. Remove the flexplate to crankshaft retaining bolts (2).
2. Remove the flexplate (1).

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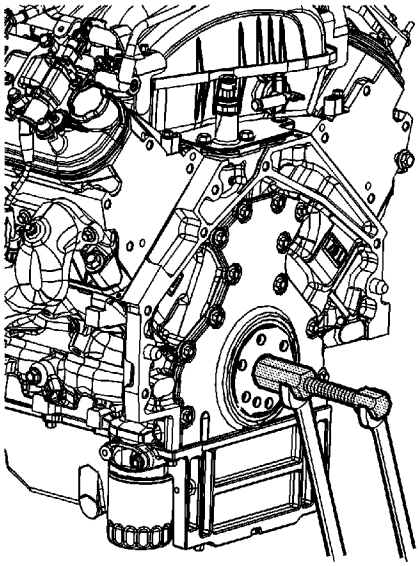
Clutch Pilot Bearing Removal

Special Tools

J 43276 Clutch Pilot Bearing Remover

For equivalent regional tools, refer to Special Tools.



Caution: When using the J 43276 Clutch Pilot Bearing Remover, always secure the J 43276-1 Clutch Pilot Bearing Remover tool body using a wrench. Do not allow the J 43276-1 tool body to rotate. Failing to do so causes damage to the J 43276-1 tool body.

1. Remove the clutch pilot bearing using the *J 43276* remover .
   1.1. Install the J 43276-1 into the clutch pilot bearing.
   1.2. Using a wrench, secure the J 43276-1.
   1.3. Insert the J 43276-2 into the J 43276-1.
   1.4. Rotate the J 43276-2 clockwise into the J 43276-1 until the clutch pilot bearing is completely removed from the crankshaft.
   1.5. Rotate the J 43276-2 counterclockwise to remove the J 43276-2 from the J 43276-1.
   1.6. Remove the J 43276-1 from the tool body.

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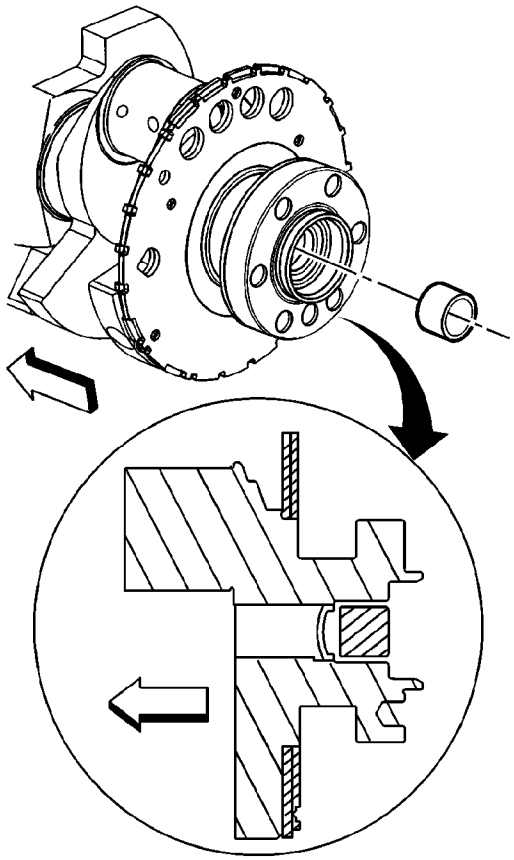
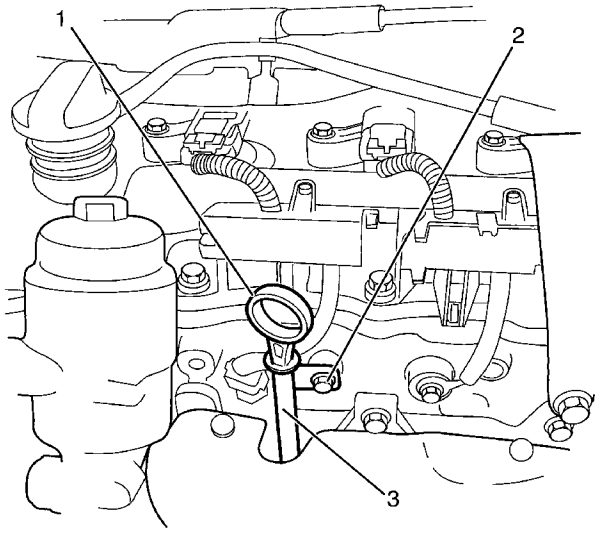
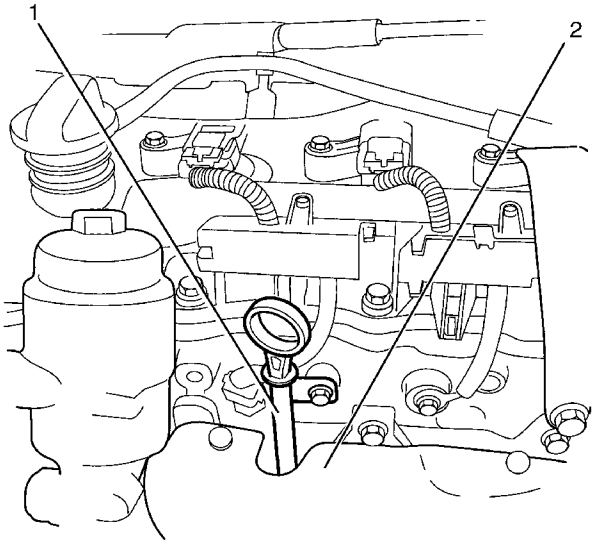


2. Discard the pilot bearing.

Oil Level Indicator and Tube Removal



1. Remove the oil level indicator tube bracket to cylinder head retaining bolt (2).
2. Remove the oil level indicator (1) from the oil level indicator tube (3).
3. Remove the knock sensor. Refer to Knock Sensor Replacement - Bank 2.



4. Remove the oil level indicator tube (1) up through the exhaust manifold (2).

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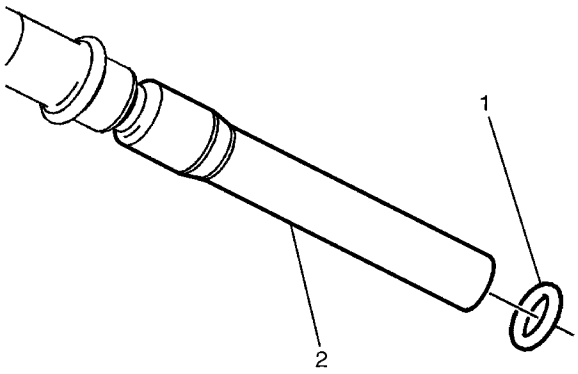
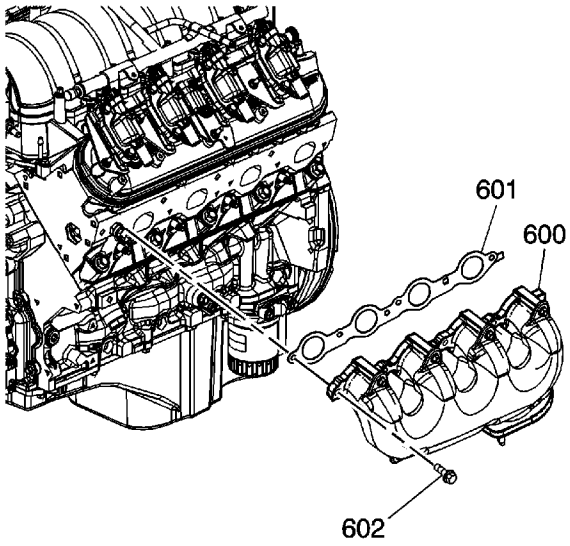
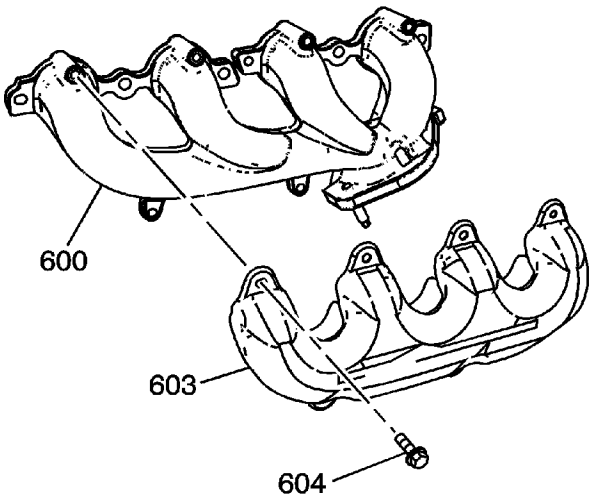


5. Remove and discard the O-ring (1) from the oil level indicator tube (2) if damaged.

Exhaust Manifold Removal - Left Side



1. Remove the spark plug wires from the spark plugs.
2. Remove the exhaust manifold (600), bolts (602), and gasket (601).
3. Discard the gasket.



4. Remove the heat shield (603) and bolts (604) from the manifold (600), as required.

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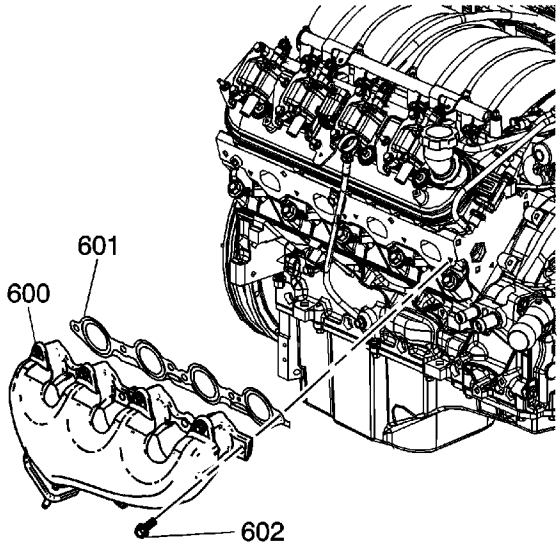
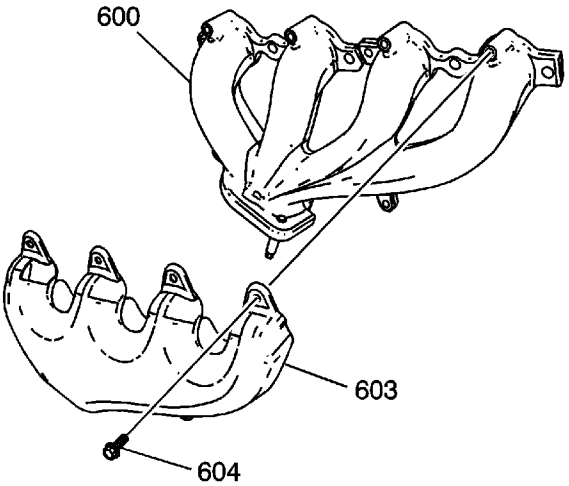
Exhaust Manifold Removal - Right Side



1. Remove the spark plug wires from the spark plugs.
2. Remove the exhaust manifold (600), bolts (602), and gasket (601).
3. Discard the gasket.



4. Remove the heat shield (603) and bolts (604) from the manifold (600), as required.

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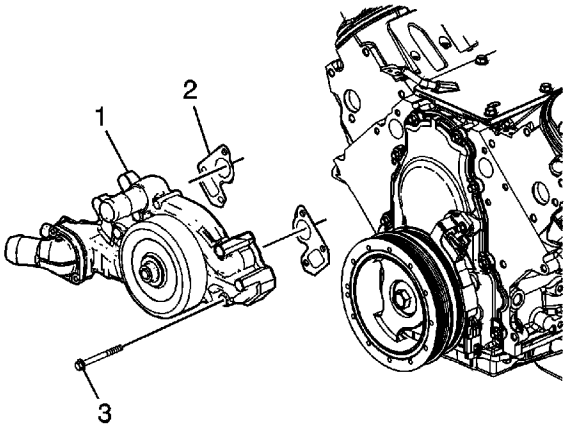
Water Pump Removal



1. Remove the water pump bolts (3).
2. Remove the water pump (1) and gaskets (2).
3. Discard the water pump gaskets.

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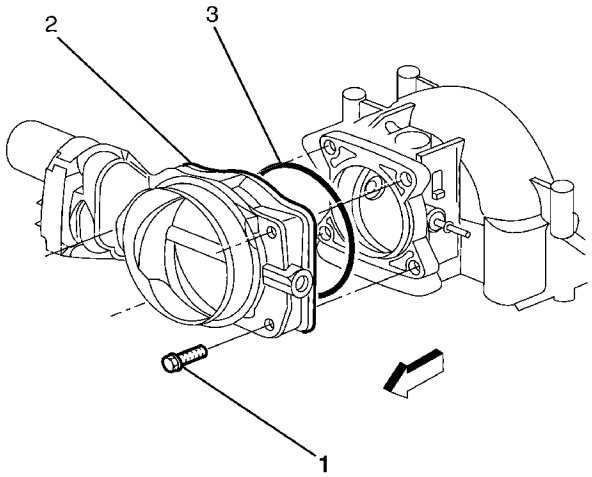
Throttle Body Removal



Caution: Handle the electronic throttle control components carefully. Use cleanliness in order to prevent damage. Do not drop the electronic throttle control components. Do not roughly handle the electronic throttle control components. Do not immerse the electronic throttle control components in cleaning solvents of any type.

Note: The intake manifold, throttle body, fuel injection rail, and fuel injectors may be removed as an assembly. If not servicing the individual components, remove the manifold as a complete assembly.

1. Remove the throttle body to intake manifold retaining bolts (3).
2. Remove the throttle body (1).
3. Remove the throttle body gasket (2).

Discard the throttle body gasket (2).

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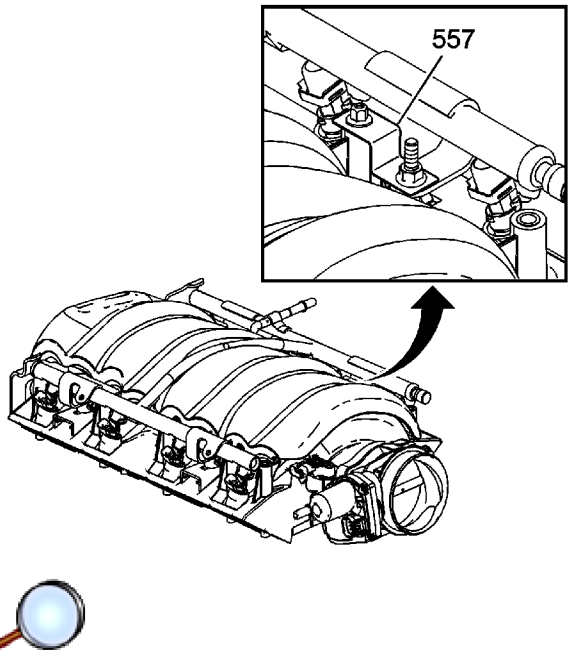
Fuel Rail and Injectors Removal

Warning: Refer to Fuel Rail Stop Bracket Installation Warning in the Preface section.



Note:

- The intake manifold, throttle body, fuel injection rail and fuel injectors may be removed as an assembly. If not servicing the individual components, remove the intake manifold as a complete assembly.
- Do not separate the fuel injectors from the fuel rail unless component service is required.
- Use cleanliness and care when handling the fuel system components. Do not allow dirt or debris to enter the fuel injectors or fuel rail components. Cap ends as necessary.

1. Note the location of the fuel rail ground strap (557).

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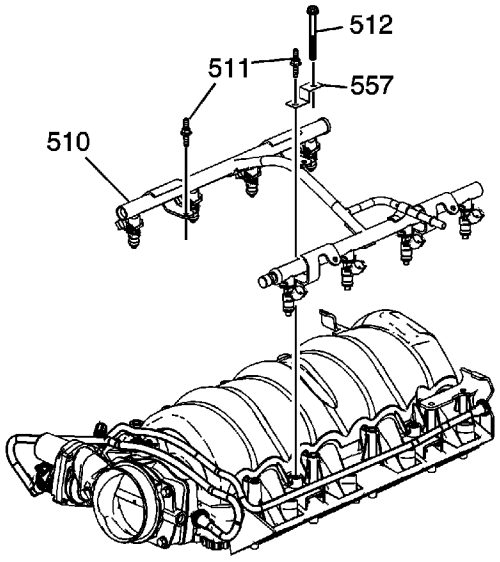
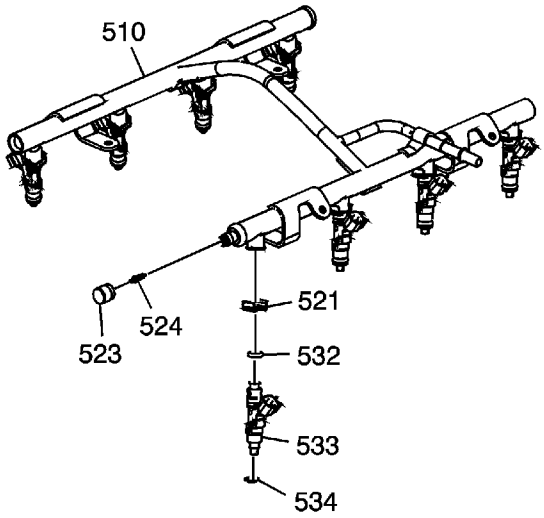
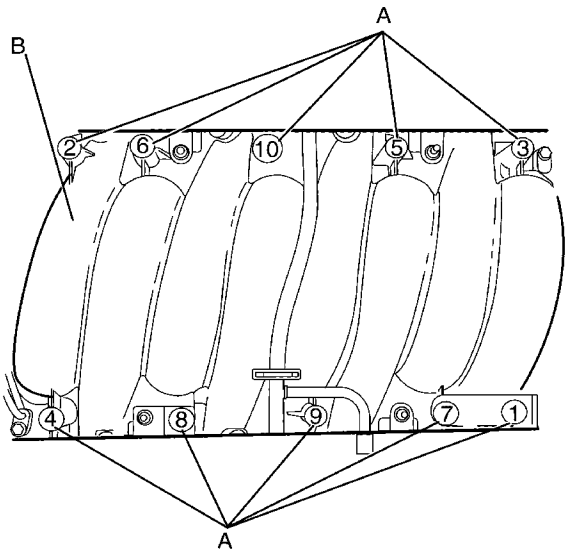


2. Remove the bolts (511 and 512), ground strap (557), and fuel rail with injectors (510). Lift evenly on both sides of the fuel rail until all injectors have left their bores.



3. Remove the fuel injectors (533) and retainers (521).
4. Remove the O-rings (532 and 534), as required.
5. Remove the cap (523) and service valve (524), as required.

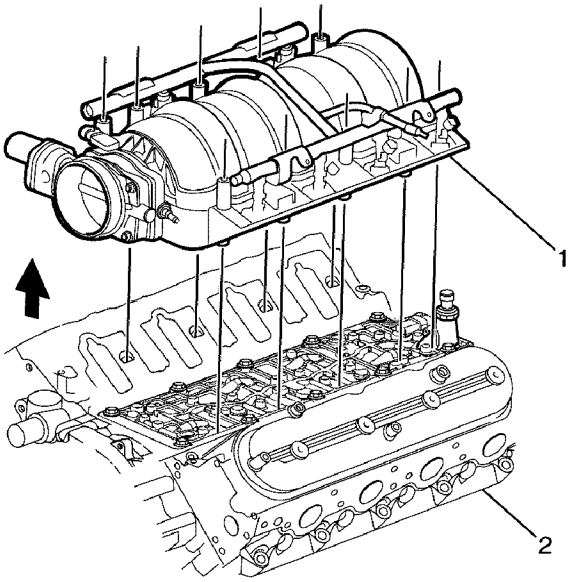
Intake Manifold Removal



Note: The intake manifold, throttle body, fuel injection rail, and fuel injectors may be removed as an assembly. If not servicing the individual components, remove the manifold as a complete assembly.

Note: Removal of the intake manifold to cylinder head retaining bolts (1-10) should be performed in sequence. Failing to do so may distort the intake manifold (B).

1. Remove the intake manifold to cylinder head retaining bolts (A) in sequence.



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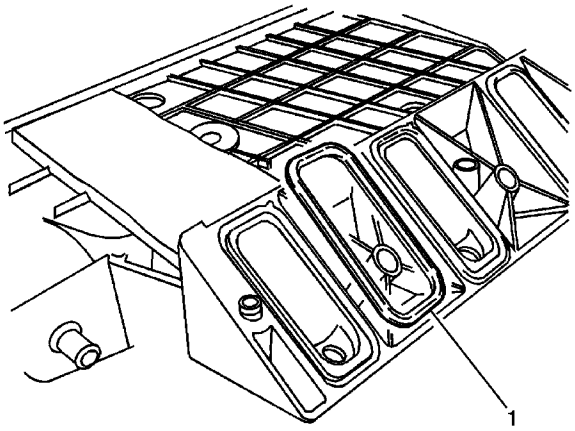
2. Remove the intake manifold (1) from the engine (2).
3. Plug the engine (2) with a clean lint free cloth.

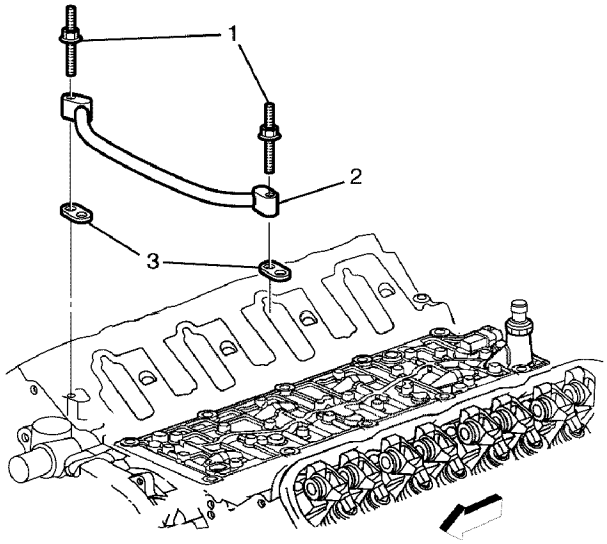


4. Remove the intake manifold to cylinder head gaskets (1).

   Discard the intake manifold to cylinder head gaskets (1).

5. Clean and inspect the intake manifold. Refer to Intake Manifold Cleaning and Inspection.

Engine Coolant Air Bleed Pipe and Hole Cover Removal



1. Remove the engine coolant air bleed pipe to cylinder head retaining bolts (1).
2. Remove the engine coolant air bleed pipe (2).

Important: The engine coolant air bleed pipe seals (3) are single use only components and must be replaced whenever engine coolant air bleed pipe (2) is removed from the engine.

3. Remove the engine coolant air bleed pipe seals (3).

   Discard the engine coolant air bleed pipe seals (3).

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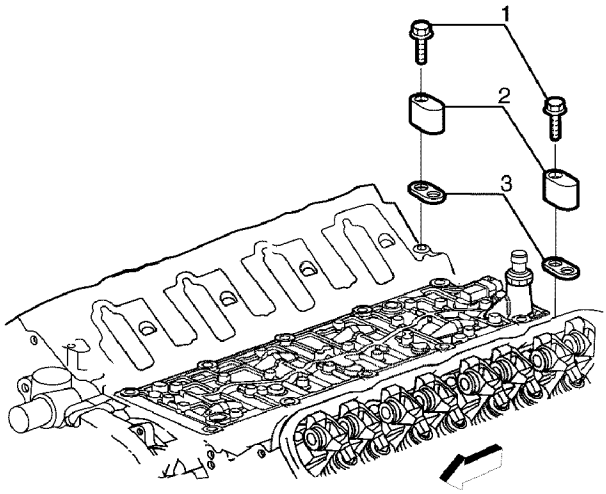


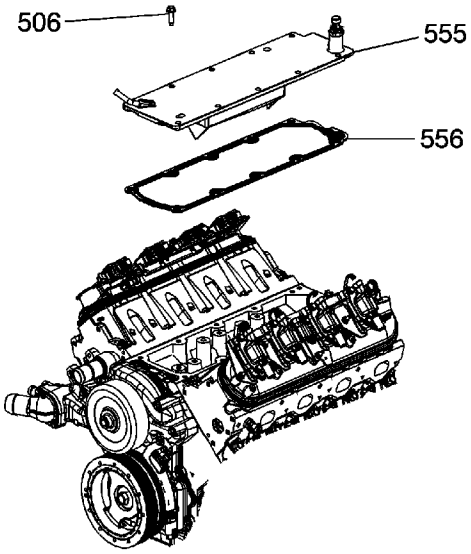
4. Remove the engine coolant air bleed cover to cylinder head retaining bolts (1).
5. Remove the engine coolant air bleed covers (2).

Important: The engine coolant air bleed cover seals (3) are single use only components and must be replaced whenever engine coolant air bleed covers (2) are removed from the engine.

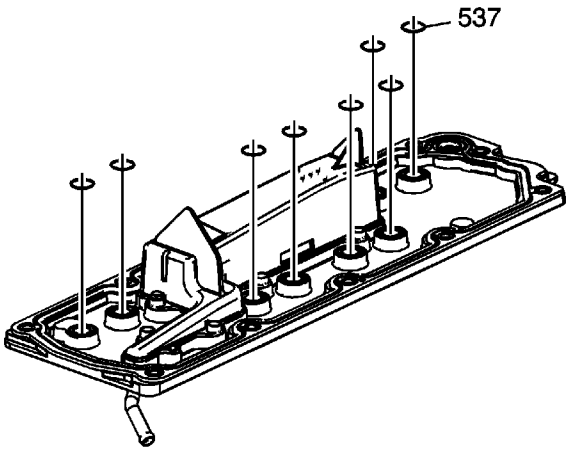
6. Remove the engine coolant air bleed cover (2) seals (3).

   Discard the engine coolant air bleed cover seals (3).

Engine Block Valley Cover Removal



1. Remove the engine block valley cover bolts (506).
2. Remove the valley cover (555) and gasket (556).



3. Remove the seals (537) from the cover.

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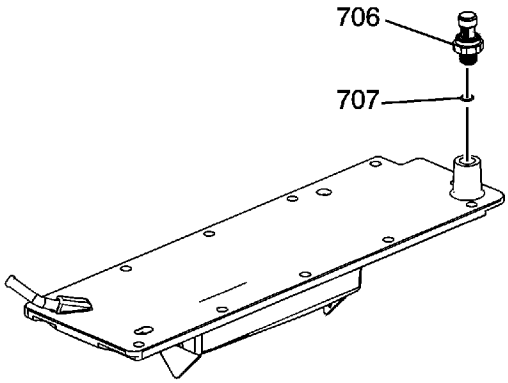
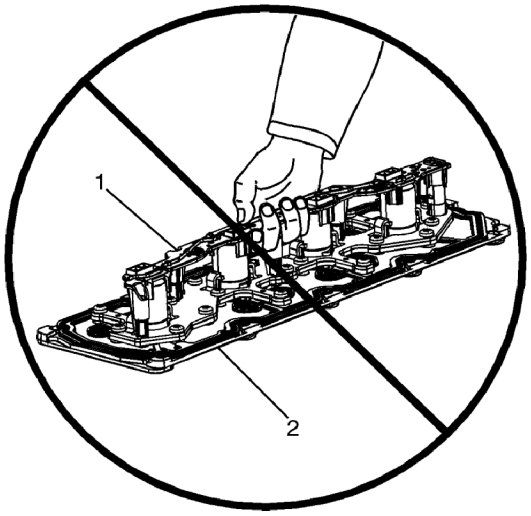
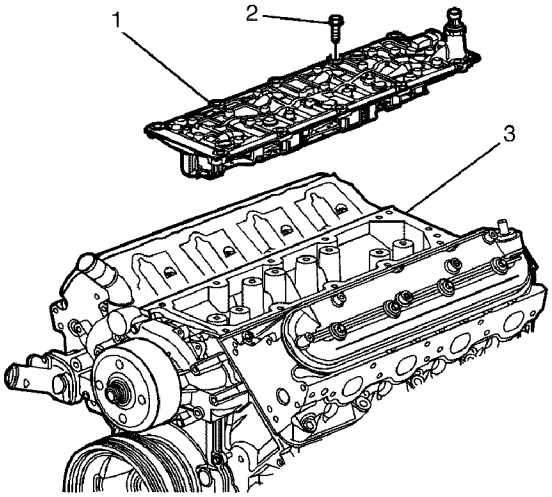


4. Remove the engine oil pressure sensor (706) and seal (707), as required.

Valve Lifter Oil Manifold Removal



1. DO NOT lift the Valve Lifter Oil Manifold (VLOM) (2) by the electrical lead frame (1).



2. Remove the VLOM to cylinder retaining bolts (2).
3. Remove the VLOM (1) from the cylinder block (3).

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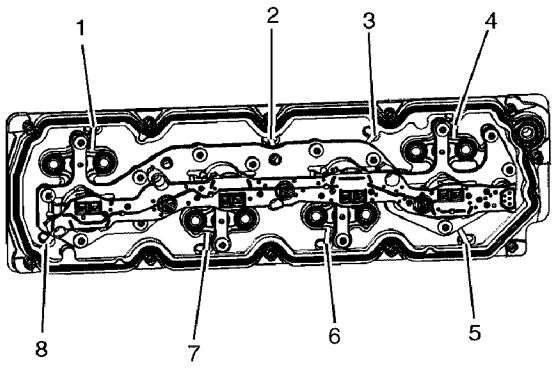
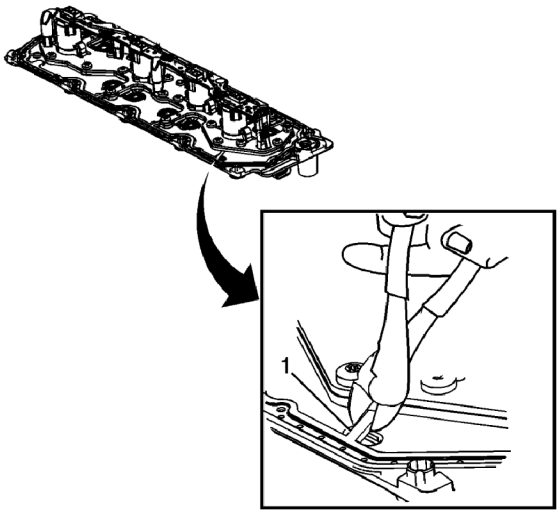
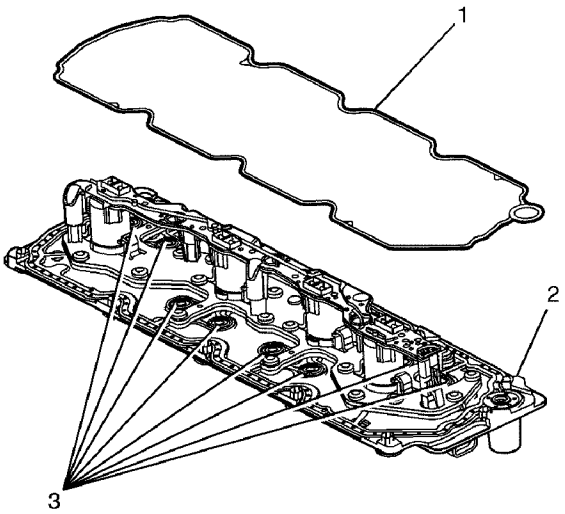


4. Identify the 8 VLOM outer gasket retaining strap locations (1-8).



Note: Remove only the outer gasket from the manifold. Do not disassemble any of the internal components of the manifold in an attempt to remove the 8 inner sealing gaskets. If the inner gaskets are cut or damaged, replace the manifold as an assembly. Only use a wire-cutter type tool in order to minimize the amount of debris. Do not use a rotary-type cutting tool on the retaining straps.

5. Cut the 8 VLOM outer gasket retaining straps (1).

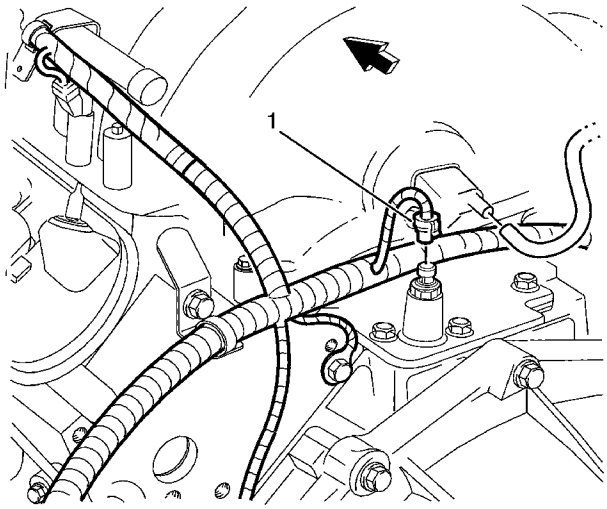


6. Remove the VLOM outer gasket (1) from the VLOM (2).

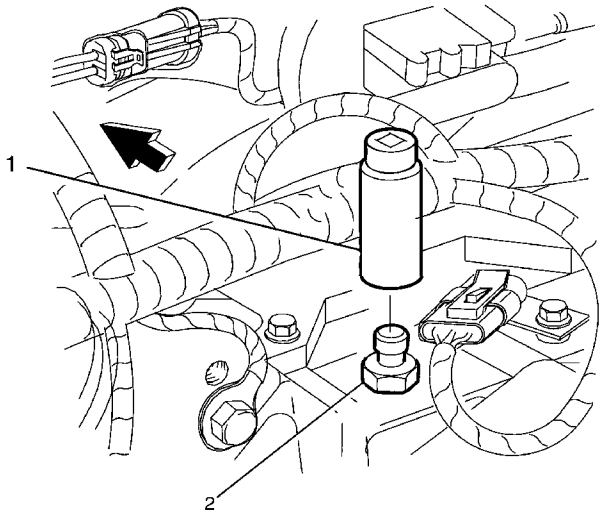
Valve Lifter Oil Filter Removal

Tools Required

J 41712 Oil Pressure Switch Socket



1. Disconnect the oil pressure sensor wiring harness connector (1).



Important: Clean the area around the oil pressure sensor (2) before removal. This prevents

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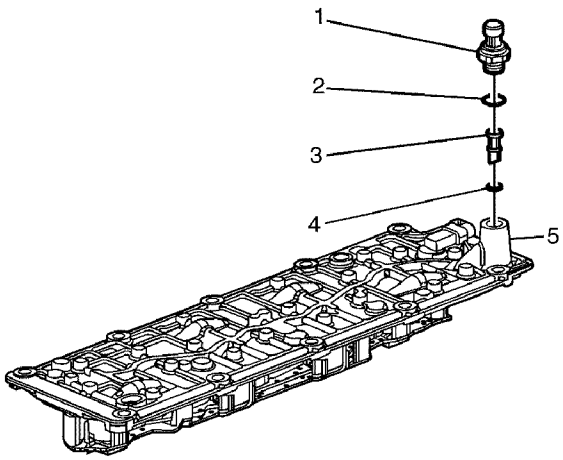
debris from entering the engine.

2. Use the J 41712 (1) to remove the oil pressure sensor (2).



3. Remove the oil pressure sensor (1) and washer (2) from the Valve Lifter Oil Manifold (VLOM) (5).

Important: The valve lifter oil filter (3) should be replaced whenever the oil pressure sensor (1) is removed.

4. Remove the valve lifter oil filter (3).

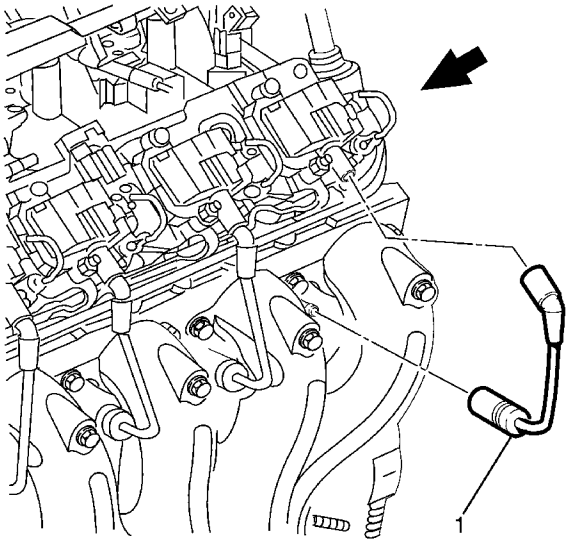
Discard the filter.

Important: The valve lifter oil filter O-ring seal (4) is a single use only part and must be replaced whenever the valve lifter oil filter (3) is removed.

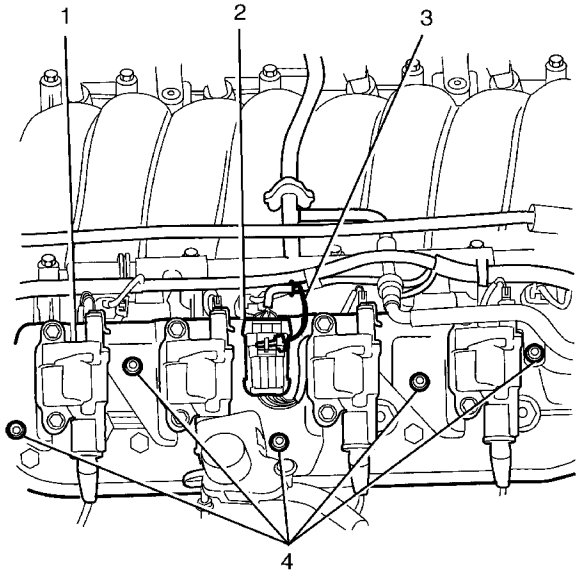
5. Remove and discard the valve lifter oil filter O-ring seal (4).

Discard the O-ring seal.

Valve Rocker Arm Cover Removal - Left Side



1. Remove the spark plug leads (1).



2. Remove the ignition coil assembly to valve rocker arm cover retaining studs (4).
3. Remove the ignition coil assembly (1).

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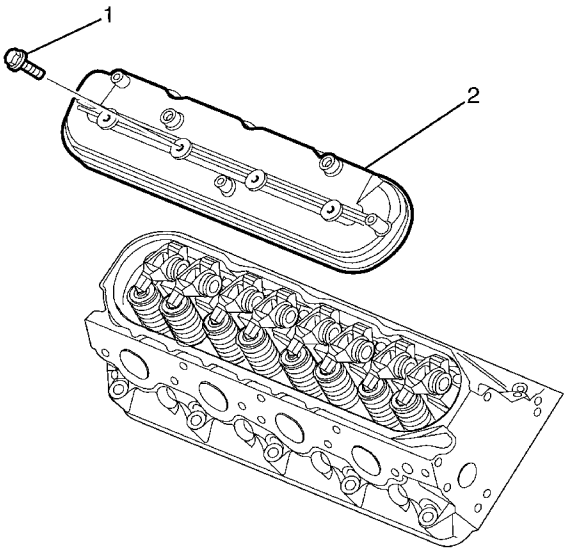
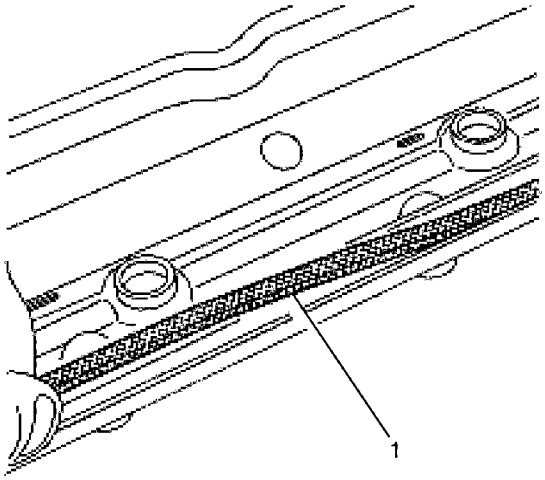


4. Loosen the valve rocker arm cover to cylinder head retaining bolts (1).
5. Remove the valve rocker cover (2).
6. Remove and discard the valve rocker arm cover gasket, valve rocker arm cover grommets and valve rocker arm cover bolts if they are serviced with the grommet.

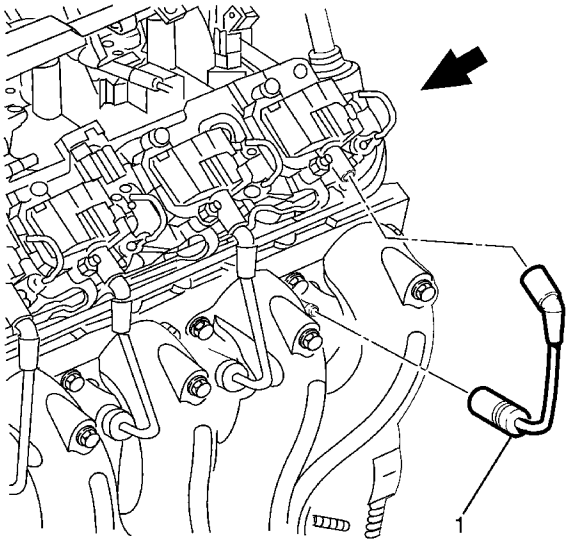


Important: The valve rocker arm cover gasket is a single use only component and must be replaced whenever the valve rocker arm cover is removed from the cylinder head.

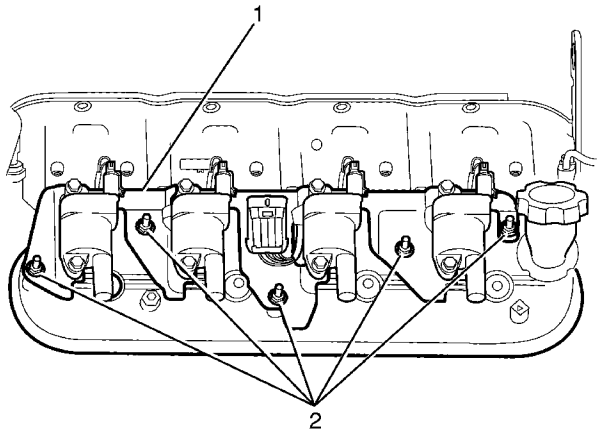
7. Remove the valve rocker arm cover gasket (1).

   Discard the valve rocker arm cover gasket (1).

Valve Rocker Arm Cover Removal - Right Side



1. Remove the spark plug leads (1).



Note: Do not remove the oil fill tube from the cover, unless service is required. If the oil fill tube has been removed from the cover, install a NEW tube during assembly.

2. Remove the ignition coil bracket retaining studs (2).
3. Remove the ignition coil and bracket assembly (1).

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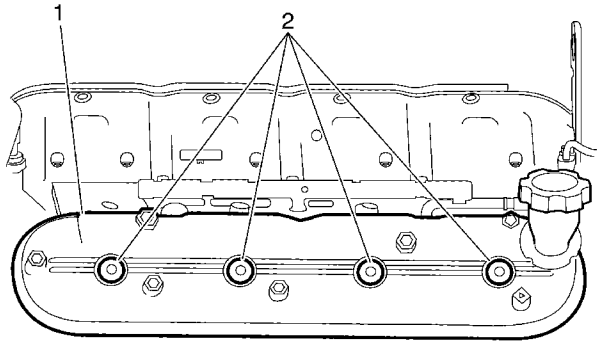
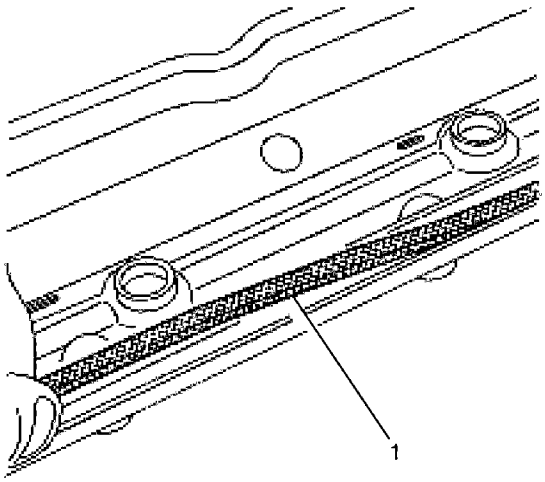


4. Remove the valve rocker arm cover retaining bolts (2) and valve rocker arm cover (1).
5. Remove and discard the valve rocker arm cover gasket, valve rocker arm cover grommets and valve rocker arm cover bolts if they are serviced with the grommet.

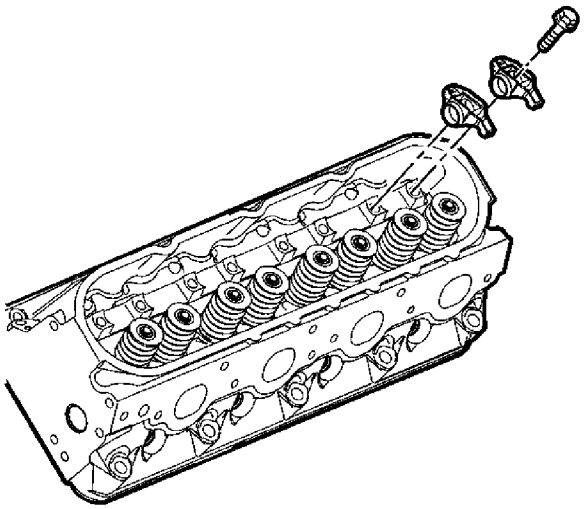


Note: The valve rocker arm cover gasket is a single use only component and must be replaced whenever the valve rocker arm cover is removed from the cylinder head.

6. Remove the valve rocker arm cover gasket (1).

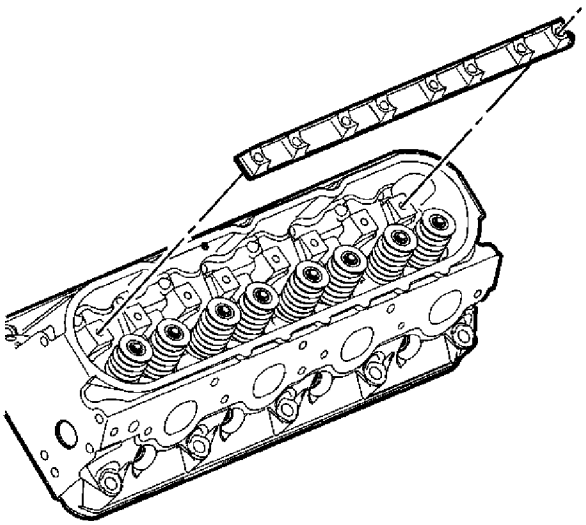
   Discard the valve rocker arm cover gasket (1).

Valve Rocker Arm and Push Rod Removal



Important: Place the valve rocker arms, valve pushrods, and pivot support, in a rack so they can be installed in the same location from which they were removed.

1. Remove the valve rocker arm bolts.
2. Remove the valve rocker arms.



3. Remove the valve rocker arm pivot support.

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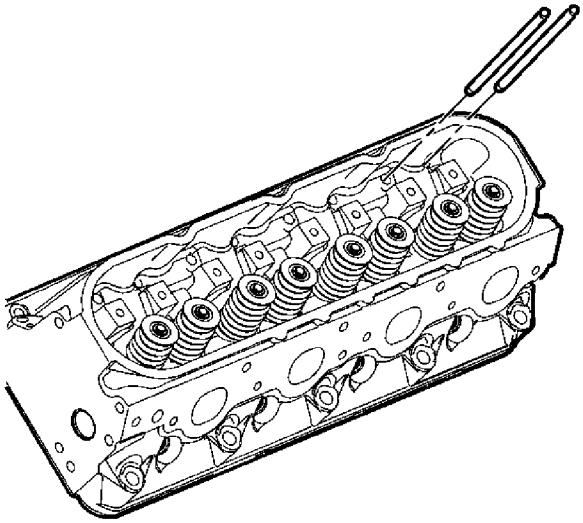
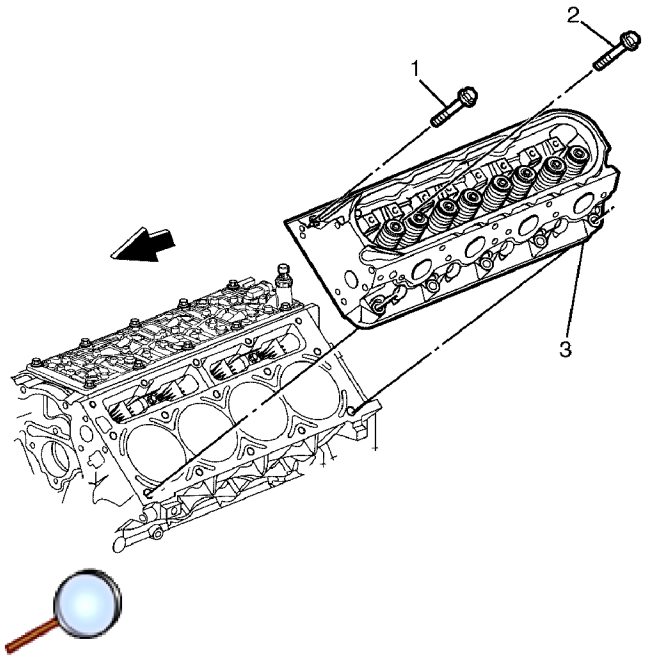


4. Remove the pushrods.

Cylinder Head Removal - Left Side



Note: The cylinder head bolts are torque to yield bolts and are single use only fasteners.

1. Remove and discard the cylinder head bolts (1) 10 places and (2) 5 places.

   Discard the bolts.

   Caution: After removal, place the cylinder head on 2 wood blocks in order to prevent damage to the sealing surfaces.

2. Remove the cylinder head (3).

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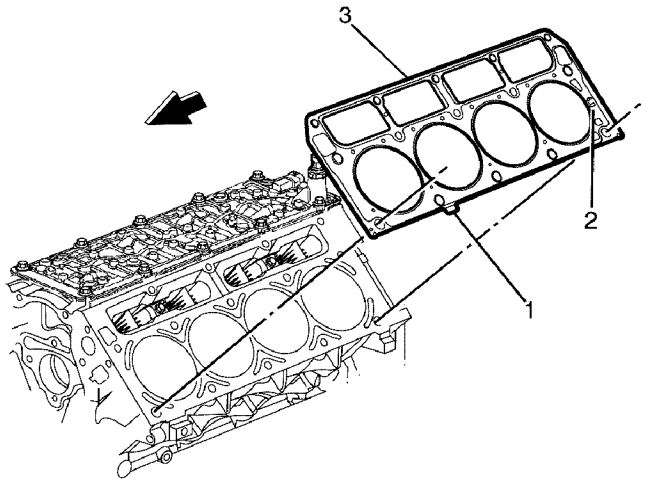


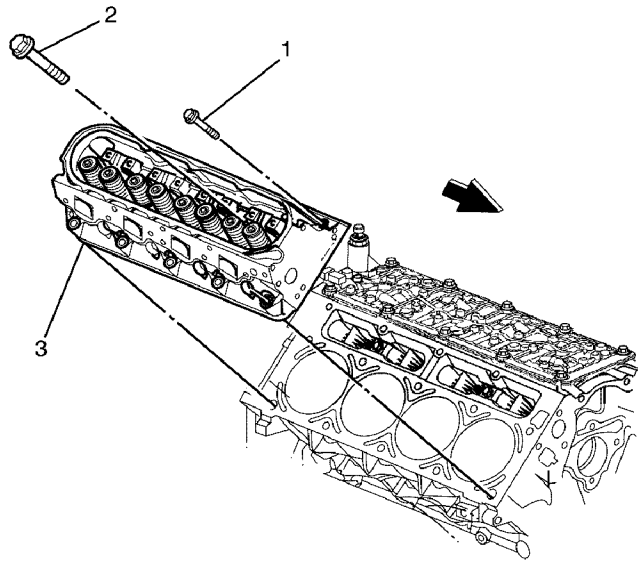
Note: Cylinder head gaskets must be discarded whenever the cylinder head has been removed from the cylinder block.

3. Remove the cylinder head gasket (1).

   Discard the gasket.

4. Clean and inspect the cylinder head and the cylinder block sealing surfaces. Refer to Cylinder Head Cleaning and Inspection and Engine Block Cleaning and Inspection.
5. If necessary, disassemble the cylinder head. Refer to Cylinder Head Disassemble.

Cylinder Head Removal - Right Side



Note: The cylinder head bolts are torque to yield bolts and are single use only fasteners.

1. Remove and discard the cylinder head bolts (1) 10 places, (2) 5 places.

   Discard the bolts.

   Caution: After removal, place the cylinder head on 2 wood blocks in order to prevent damage to the sealing surfaces.

2. Remove the cylinder head (3).

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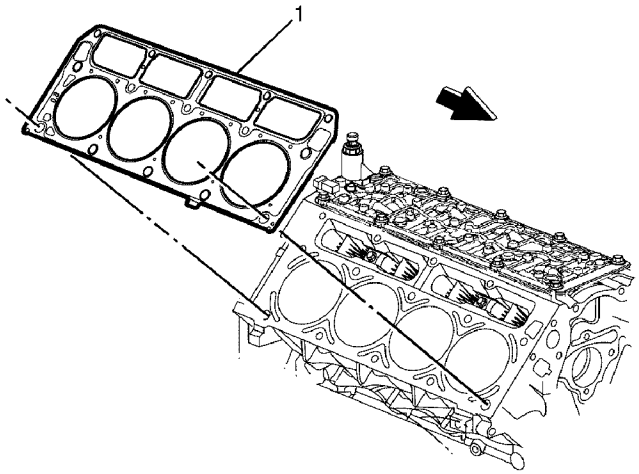


3. Remove the cylinder head gasket (1).

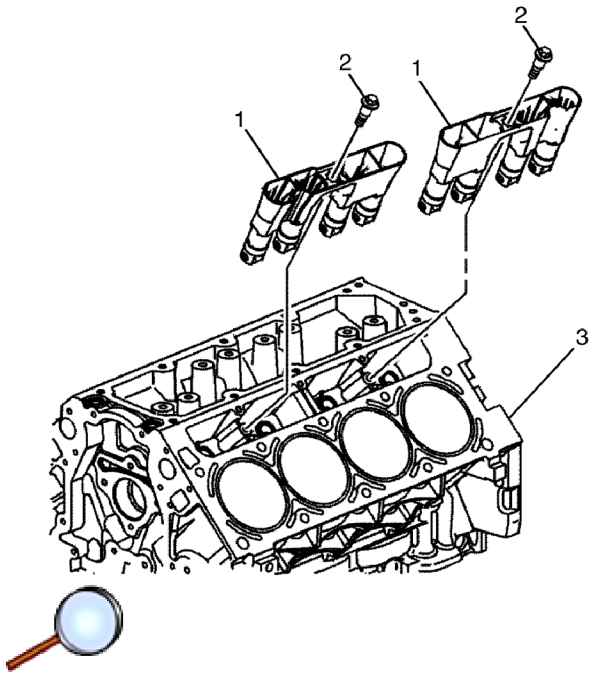
   Discard the gasket.

4. Clean and inspect the cylinder head and the cylinder block sealing surfaces. Refer to Cylinder Head Cleaning and Inspection and Engine Block Cleaning and Inspection.
5. If necessary, disassemble the cylinder head. Refer to Cylinder Head Disassemble.

Valve Lifter Removal

Tools Required

J 3049-A Valve Lifter Remover.



1. Remove the lifter guide to cylinder block retaining bolts (2).

   Important: Note the installed position of the valve lifter guides (1). The notched area of the valve lifter guides (1) are to align with the locating tab on the cylinder block (3).

2. Remove the valve lifter guides (1) and valve lifters as an assembly from the cylinder block (3).

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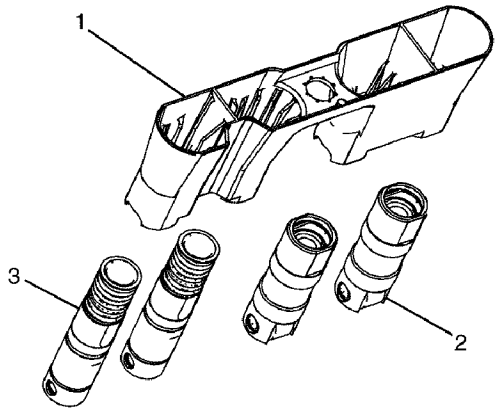
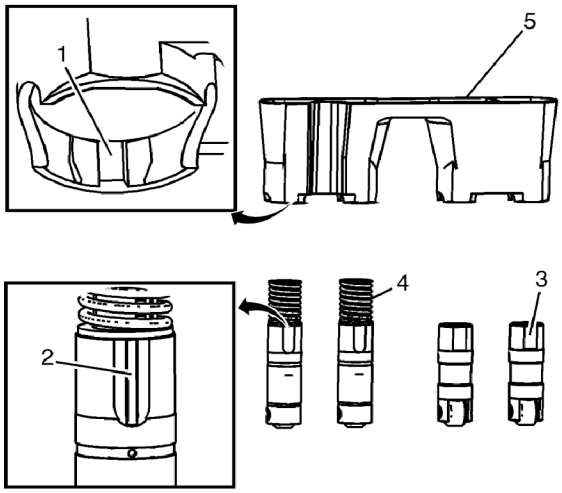


3. Remove the valve lifters (2 and 3) from the valve lifter guide (1).

Important: Some valve lifters (2 or 3) may be stuck in their bores because of gum or varnish deposits.

4. Use J 3049-A J 3049-A or equivalent in order to remove the valve lifters (2 and 3), if required.

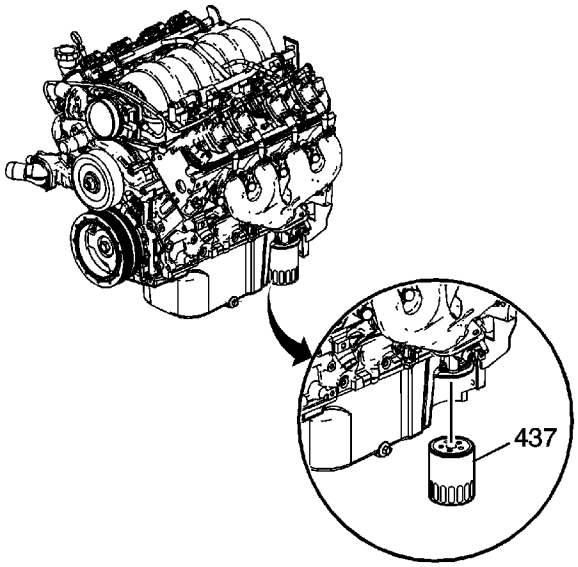


Important: The cylinder deactivation lifters (4) are installed into the guide (5) by aligning the notched area of the guide (1) with the raised surface on the side of the lifter (2).

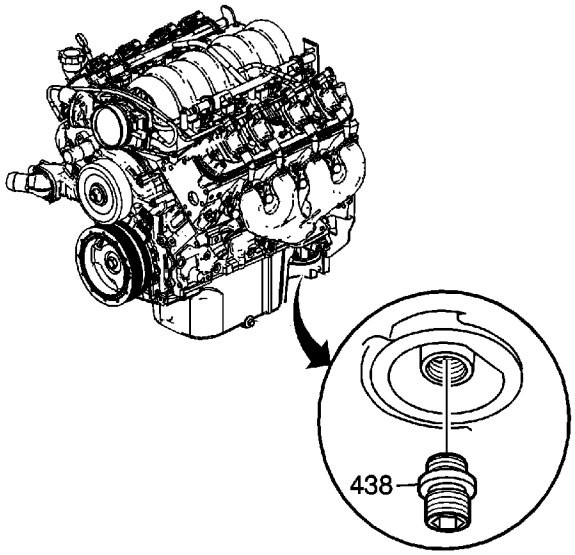
5. When using the valve train components again, always install the components to the original location and position. Refer to Separating Parts.

6. Clean and inspect the valve lifters (3 and 4), if required. Refer to Valve Lifter and Guide Cleaning and Inspection.

Oil Filter, Adapter, and Pan Cover Removal



1. Remove the oil filter (437).



2. Remove the oil filter fitting (438) as required.

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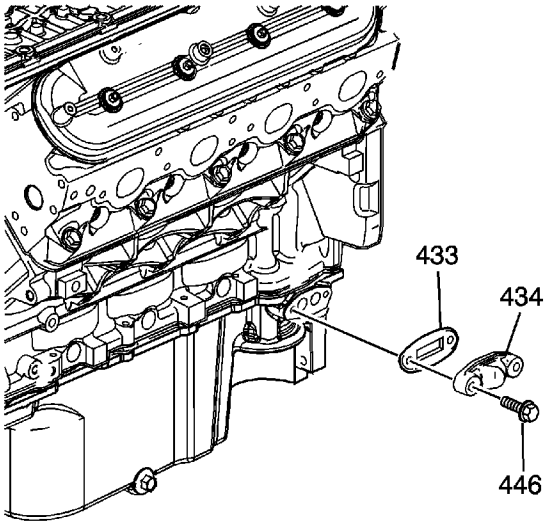
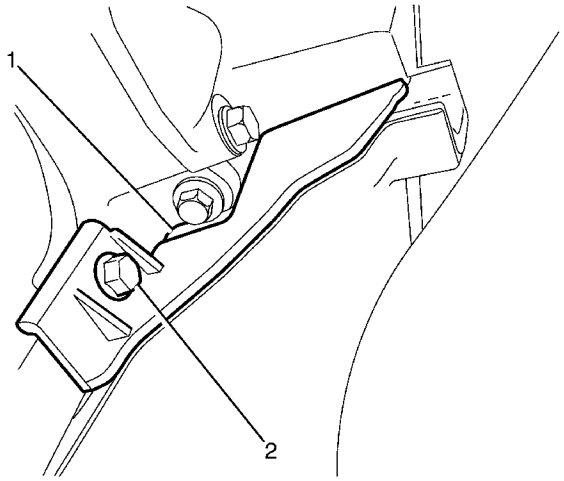


3. Remove the bolts (446), cover (434), and gasket (433).

Oil Pan Removal

Removal Procedure



Note:

- The original oil pan gasket is retained and aligned to the oil pan by rivets. When installing a new gasket, it is not necessary to install new oil pan gasket rivets.
- DO NOT use the oil pan gasket again. When installing the oil pan, install a NEW oil pan gasket.

1. Remove the left side close out cover to cylinder block retaining bolt (2).
2. Remove the left side close out (1).

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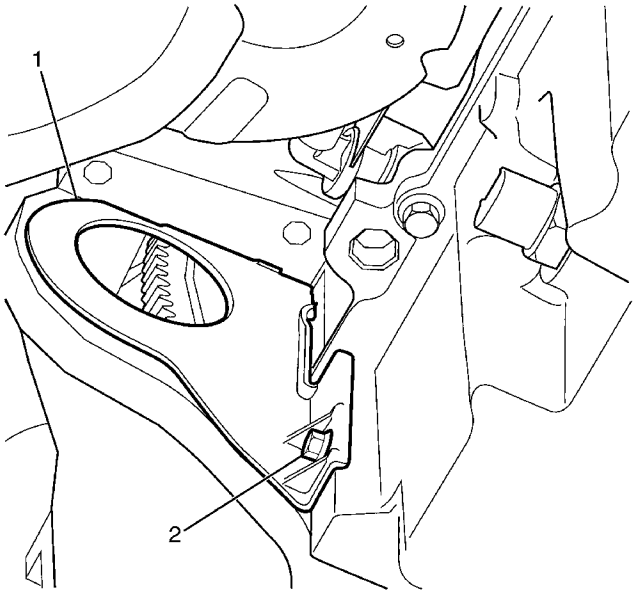
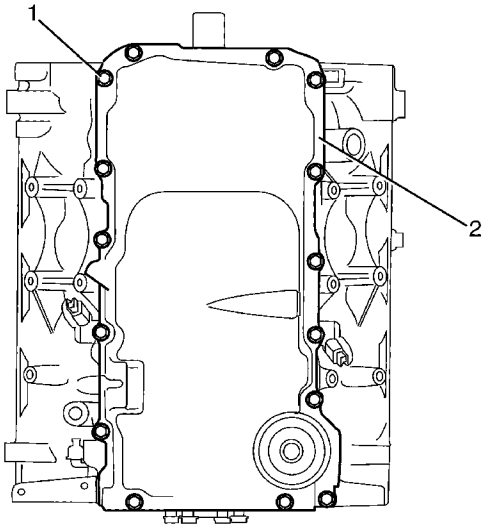
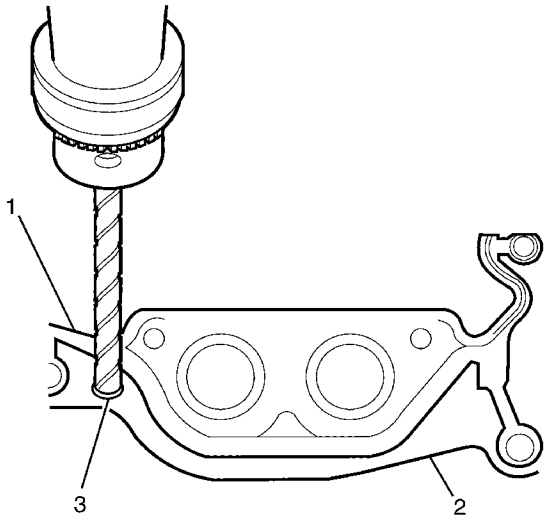


3. Remove the right side close out cover to cylinder block retaining bolt (2).
4. Remove the right side close out (1).



5. Remove the oil pan to cylinder block retaining bolts (1 and 3).
6. Remove the oil pan (2).



Note:

- DO NOT allow foreign material to enter the oil passages of the oil pan. Cap or cover the openings, as required.
- Use care not to gouge, score, or damage the oil pan sealing surface.

7. Drill (3) out the retaining rivets, if required.

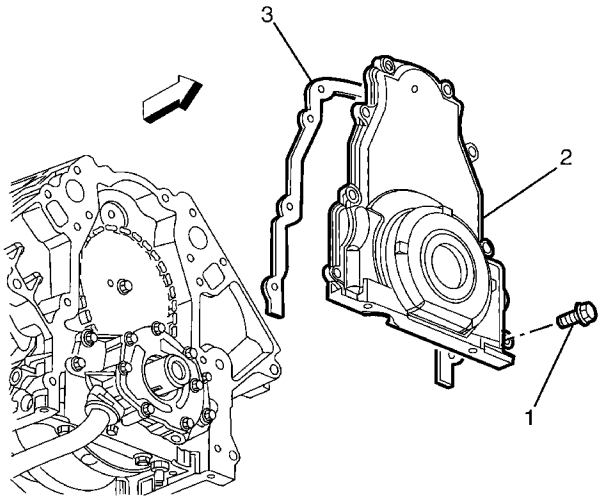
   Important: The oil pan gasket and rivets are single use only components and must be replaced whenever the oil pan is removed from the cylinder block.

8. Remove the oil pan gasket (1) from the oil pan.

   Discard the gasket and rivets.

Engine Front Cover Removal

1. Remove the camshaft position sensor (CMP). Refer to Camshaft Position Sensor Replacement.



2. Remove the engine front cover to cylinder block retaining bolts (1).

   Important: The engine front cover gasket (3) is a single use only component and must be replaced whenever the engine front cover (2) is removed.

3. Remove the engine front cover (2) and gasket (3).
4. Remove the engine front cover gasket (3).

   Discard the engine front cover gasket (3).

5. Clean and inspect the engine front cover. Refer to Engine Front Cover Cleaning and Inspection

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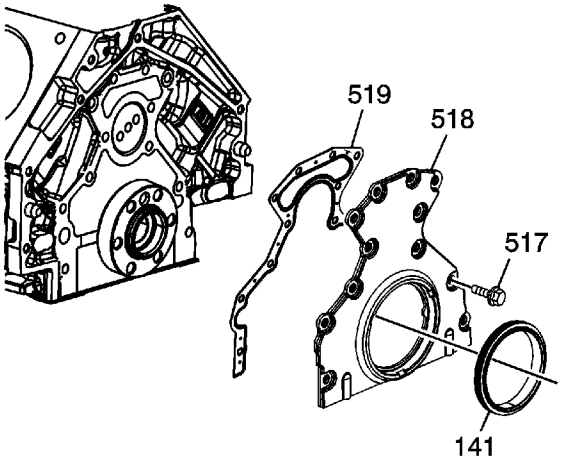
Crankshaft Rear Oil Seal Housing Removal



1. Remove the rear oil seal housing bolts (517).
2. Remove the housing (518) and gasket (519).
3. Remove the rear oil seal (141).

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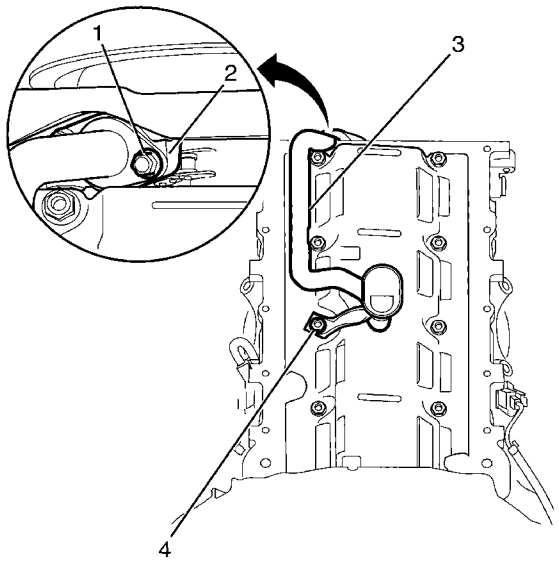
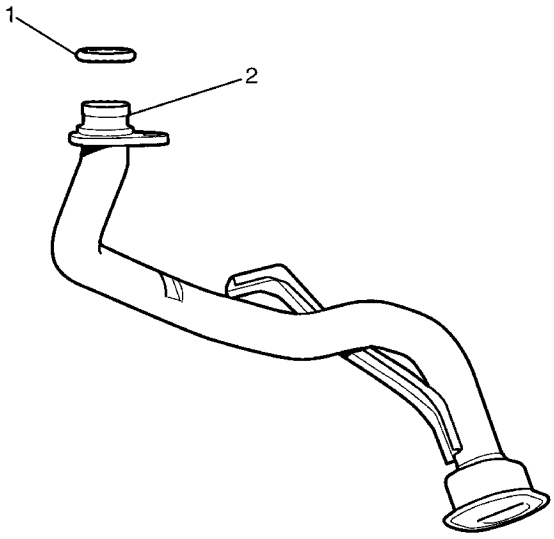
Oil Pump, Screen and Crankshaft Oil Deflector Removal



1. Remove the oil pump screen and tube assembly to oil pump retaining bolt (1).
2. Remove the oil pump screen and tube assembly to crankshaft oil deflector retaining nut (4).
3. Remove the oil pump screen and tube assembly (3) from the oil pump (2).



Important: The oil pump screen and tube assembly O-ring seal (1) is a single use only component and must be replaced whenever the oil pump screen and tube assembly (2) is

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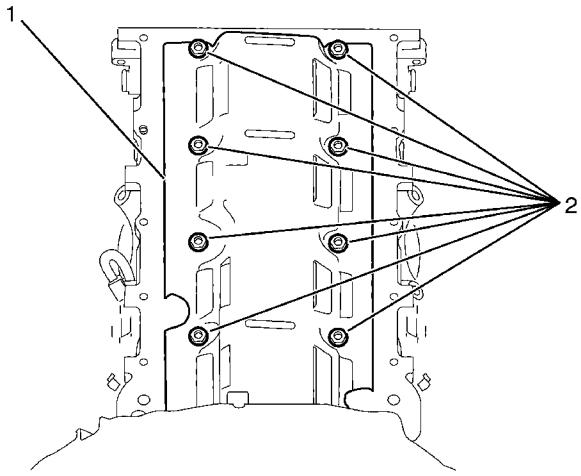
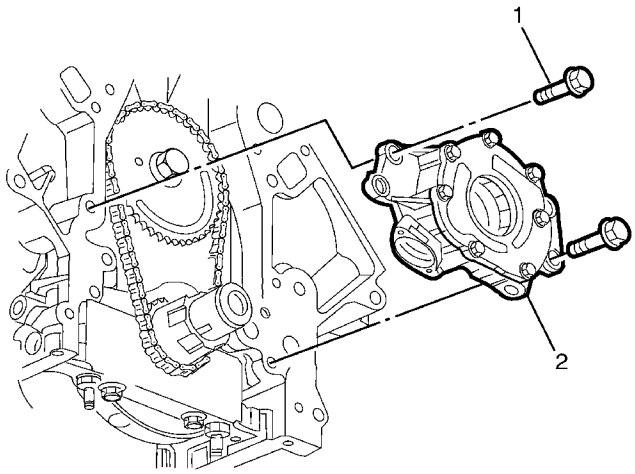
removed.

4. Remove the oil pump screen and tube assembly O-ring seal (1) from the oil pump screen and tube assembly (2).

   Discard the oil pump screen and tube assembly O-ring seal (1).



5. Remove the remaining crankshaft oil deflector retaining nuts (2).
6. Remove the crankshaft oil deflector (1).



7. Remove the oil pump bolt (1).

Important: Do not allow dirt or debris to enter the oil pump, cap the ends as necessary.

8. Remove the oil pump (2).
9. Clean and inspect the oil pump. Refer to Oil Pump Cleaning and Inspection.

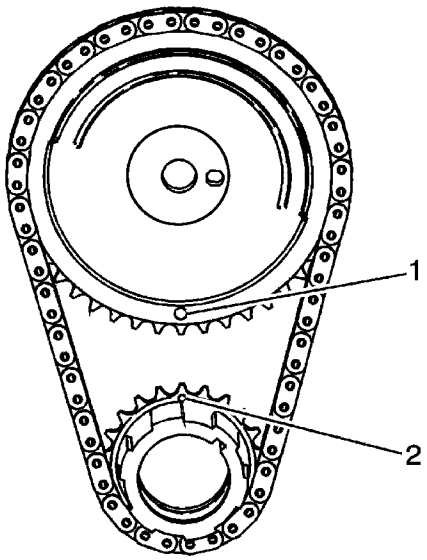
Timing Chain and Sprocket Removal

Special Tools

- *J 8433-1* Puller Bar
- *J 41558* Crankshaft Sprocket Remover
- *J 41816-2* Crankshaft End Protector

For equivalent regional tools, refer to Special Tools.

Removal Procedure



1. Inspect the sprockets for correct alignment. The mark on the camshaft sprocket (1) should be located in the 6 o'clock position and the mark on the crankshaft sprocket (2) should be located in the 12 o'clock position.

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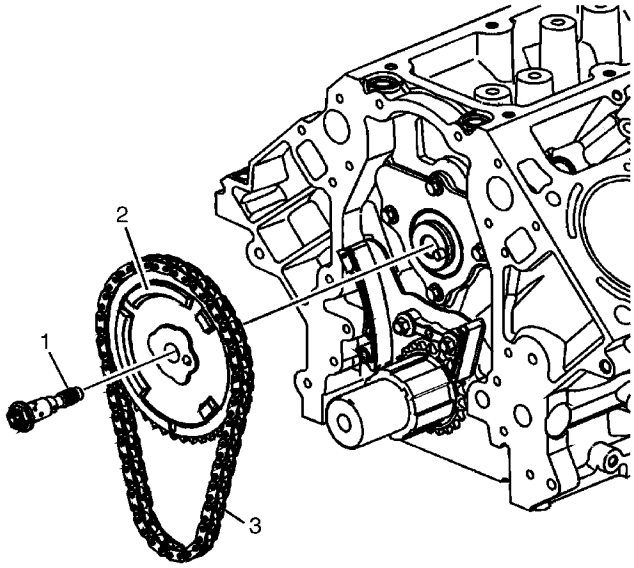
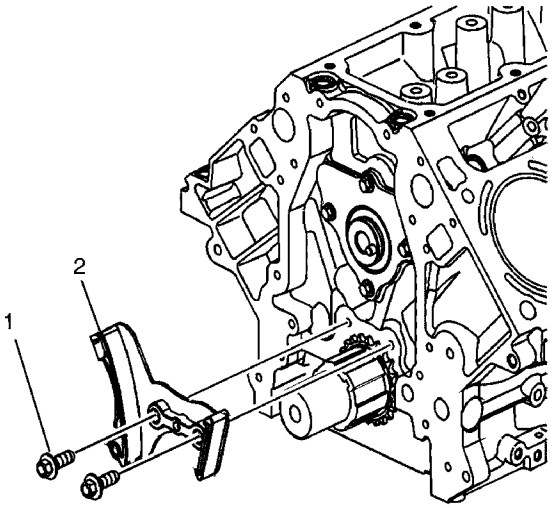
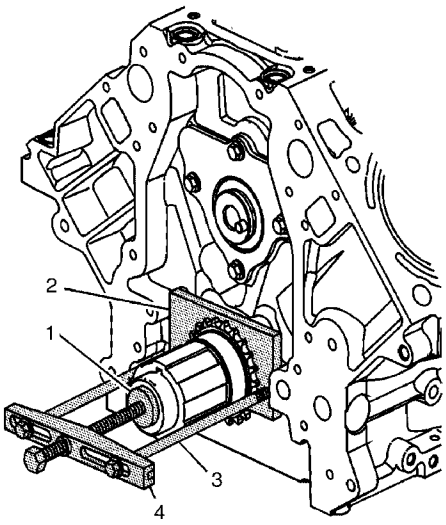


Caution: Do not turn the crankshaft assembly after the timing chain has been removed in order to prevent damage to the piston assemblies or the valves.

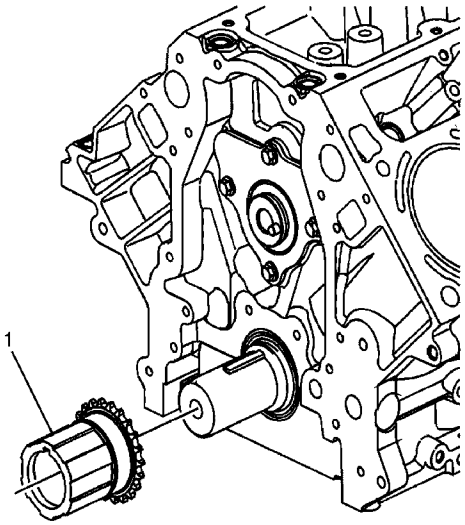
2. Remove the camshaft sprocket bolt (1).
3. Remove the camshaft sprocket (2) and timing chain (3).



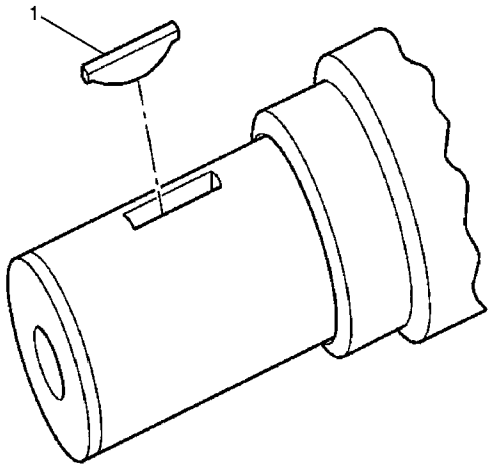
4. Remove the timing chain tension bolts (1) and tensioner (2).



5. Using the *J 41816-2* protector (1), the *J 41558* remover (2), bolts (3) and the *J 8433-1* puller (4) in order to remove the crankshaft sprocket.

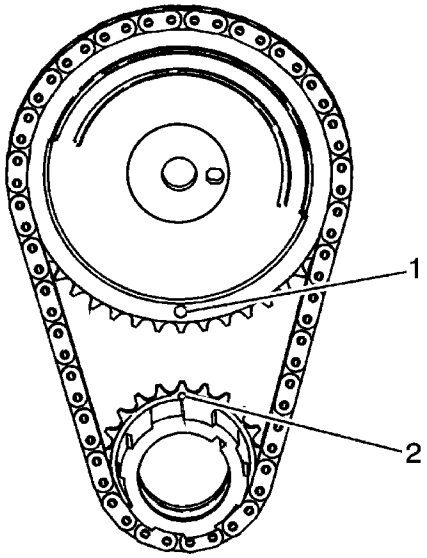


6. Remove the crankshaft sprocket (1).

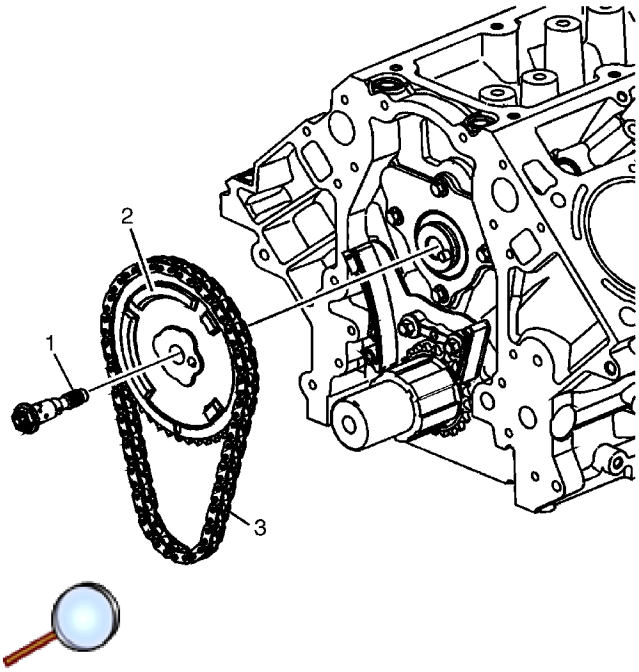


7. Remove the crankshaft sprocket key (1), if required.

Camshaft Removal



1. Rotate the engine in order to align the timing marks (1, 2).



2. Remove the camshaft sprocket to camshaft retaining bolt (1).
3. Remove the timing chain (3), from the camshaft sprocket (2), and allow the timing chain (3) to rest on the crankshaft sprocket (2).

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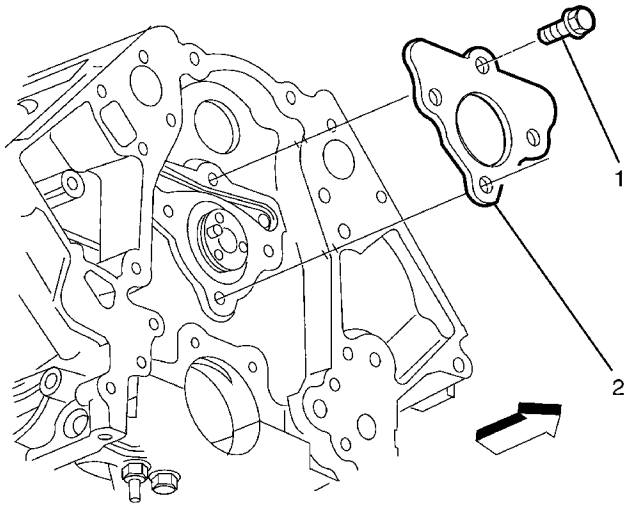
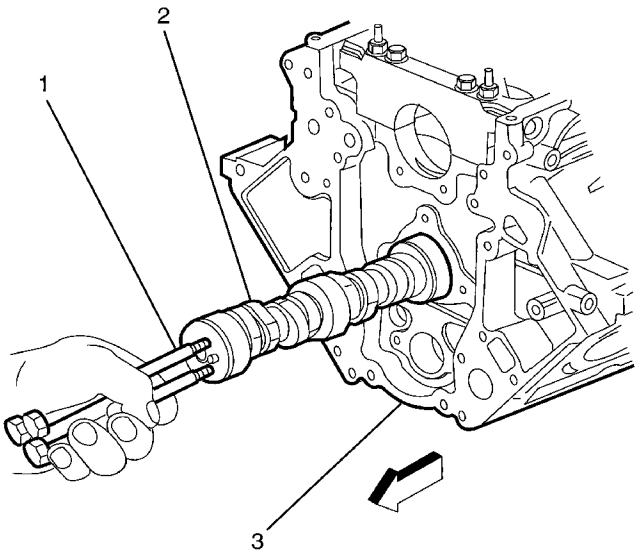


4. Remove the camshaft retainer to cylinder block retaining bolts (1) and remove the camshaft retainer (2).



Caution: All camshaft journals are the same diameter, so care must be used in removing or installing the camshaft to avoid damage to the camshaft bearings.

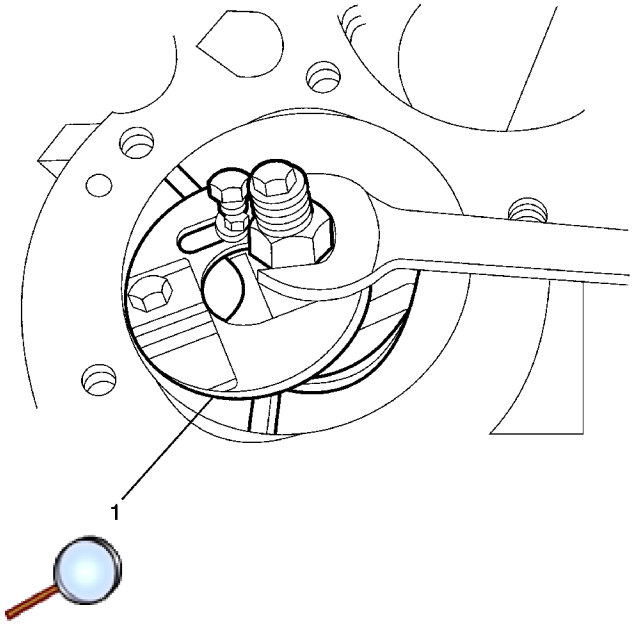
5. Remove the camshaft (2).
   5.1. Install M8 -1.25 x 100 mm (M8 -1.25 x 4.0 in) bolts (1) in the front of the camshaft (2).
   5.2. Using the bolts (1) as a handle, carefully rotate and pull the camshaft (2) out of the cylinder block (3).
   5.3. Remove the bolts (1) from the camshaft (3).

6. If required, clean and inspect the camshaft (3) and bearings. Refer to Camshaft and Bearings Cleaning and Inspection.

Piston, Connecting Rod, and Bearing Removal

Tools Required

- J 24270 Cylinder Bore Ridge Reamer
- J 41556 Connecting Rod Guide



Important: Follow the manufacturer's operating instructions for the ridge remover being used.

1. Use the J 24270 or equivalent (1) in order to remove the cylinder bore ring ridge, if required.
   1.1. Turn the crankshaft until the piston is at the bottom of the stroke.
   1.2. Place a cloth on top of the piston.
   1.3. Use the J 24270 or equivalent (1), in order to remove a cylinder ring ridge.
   1.4. Turn the crankshaft so the piston is at the top of the stroke.
   1.5. Remove the cloth.
   1.6. Remove the cutting debris from the cylinder and piston.

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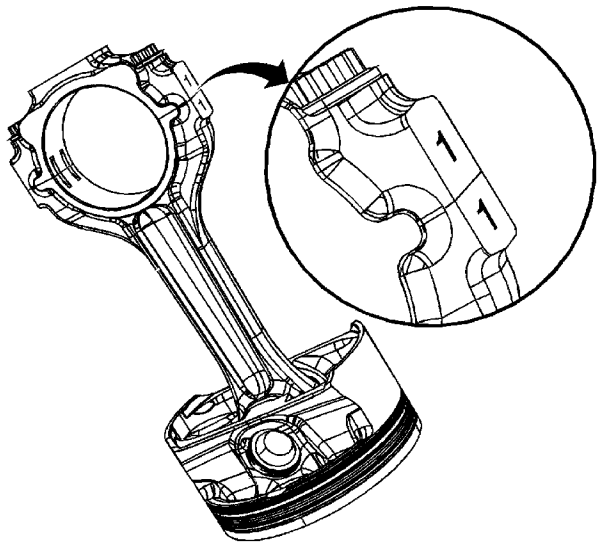
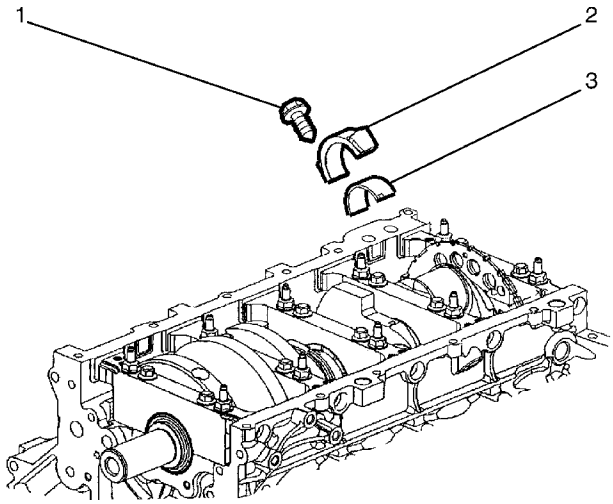


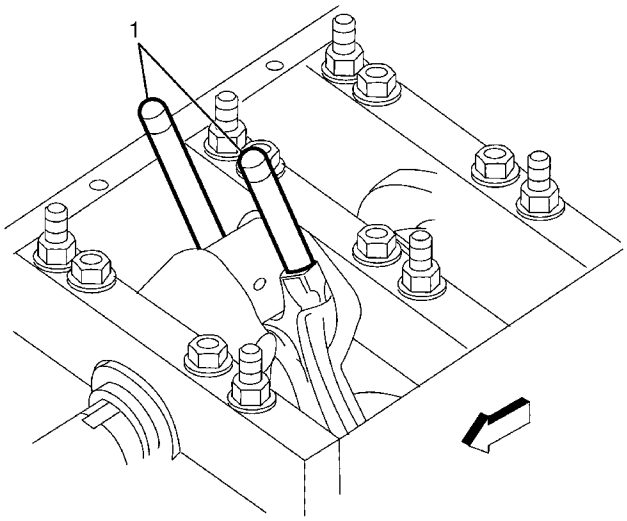
Important: Do not apply a stamping mark to any part of the connecting rod and piston assembly, A stamping mark on the side of the connecting rod, at the crankshaft journal, may affect component geometry.

2. Using a paint stick or etching tool, place match marks or numbers on the connecting rods and the connecting rod caps. The connecting rods and caps MUST be assembled to their original position and direction.
3. Mark the top of the piston to the specific cylinder bore.

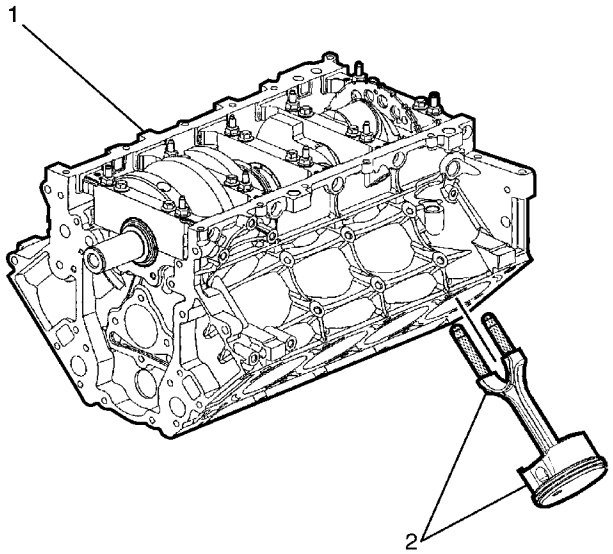


Important: Mark, sort, or organise the connecting rod bearings so they may be installed to their original position and location. The connecting rods and the bearing caps are NOT interchangeable. Refer to Separating Parts.

4. Remove the connecting rod bolts (1).
5. Remove the connecting rod bearing cap (2).
6. Remove the connecting rod bearing (3).



7. Install the J 41556 (1) to the connecting rod.
8. Using a soft hammer, tap lightly on the end of the J 41556 (1) in order to remove the piston and connecting rod assembly from the cylinder bore.



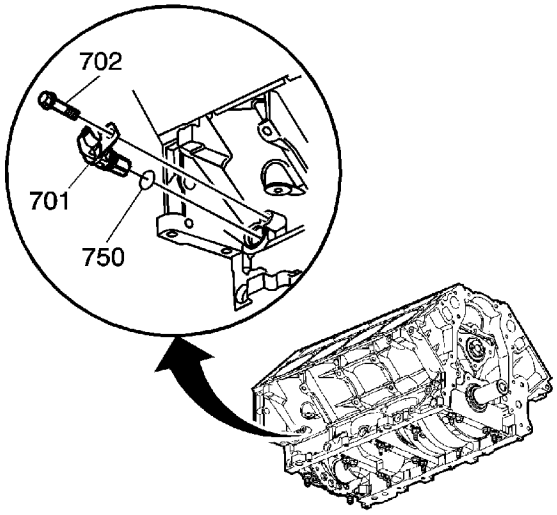
9. Remove the piston and connecting rod assembly (2) from the cylinder block (1).
10. Upon removal of the piston and connecting rod assembly, assemble the connecting rod cap and bolt onto the matching connecting rod.

Crankshaft and Bearing Removal

Special Tools

- *J 6125-1B* Slide Hammer
- *J 41818* Crankshaft Bearing Cap Remover

For equivalent regional tools, refer to Special Tools.



Note:

- The crankshaft bearing caps are machined with the engine block, for the proper clearances. Mark or identify each crankshaft bearing cap location and direction before removal. The crankshaft bearing caps MUST be installed to their original position and direction.
- Do not use the bearing cap M8 side bolts again.

1. Remove the crankshaft position (CKP) sensor bolt (702).
2. Remove the CKP sensor (701).
3. Remove the O-ring (750) from the sensor, as required.

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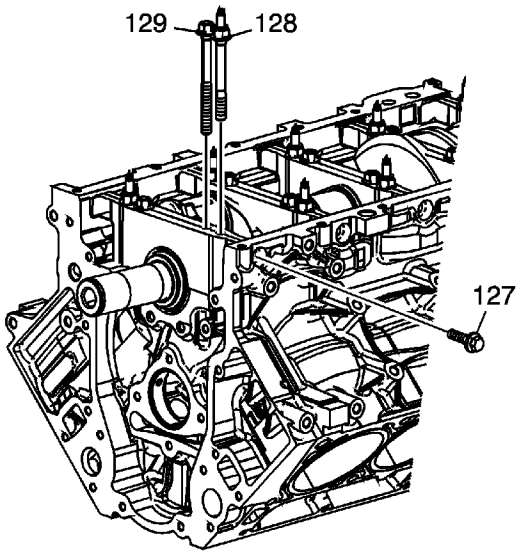
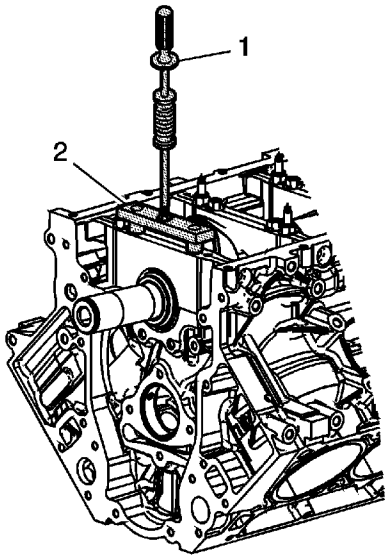
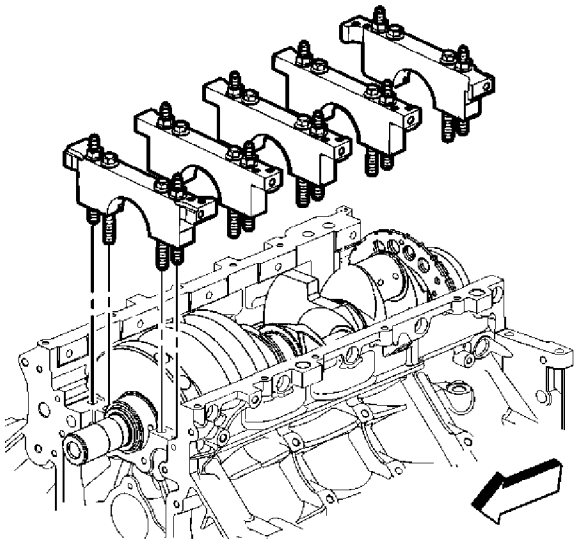


4. Remove the crankshaft bearing cap M8 bolts (127).
5. Remove the bearing cap M10 bolts (129) and studs (128).

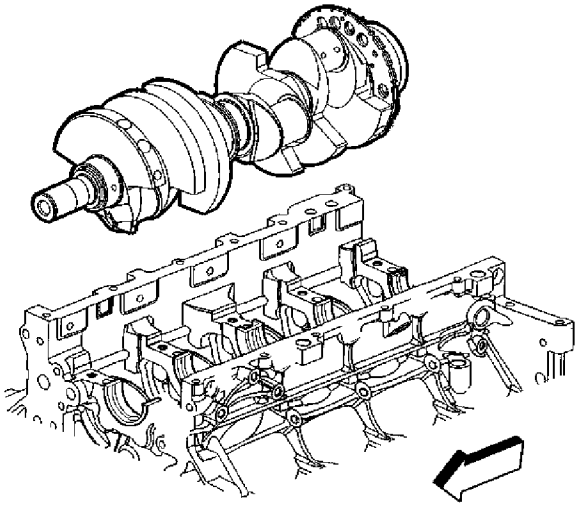
Caution: Refer to Fastener Caution in the Preface section.



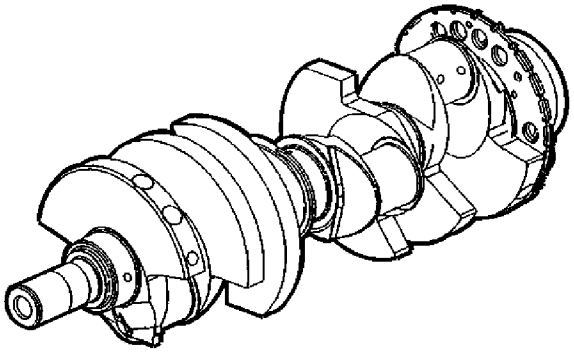
6. Install the *J 41818* remover (2). Tighten the *J 41818* remover (2) bolts to **11 N·m (100 lb in)**.
7. Install the *J 6125-1B* slide hammer (1) to the *J 41818* remover (2) in order to remove the crankshaft bearing caps.



8. Remove the bearing caps.

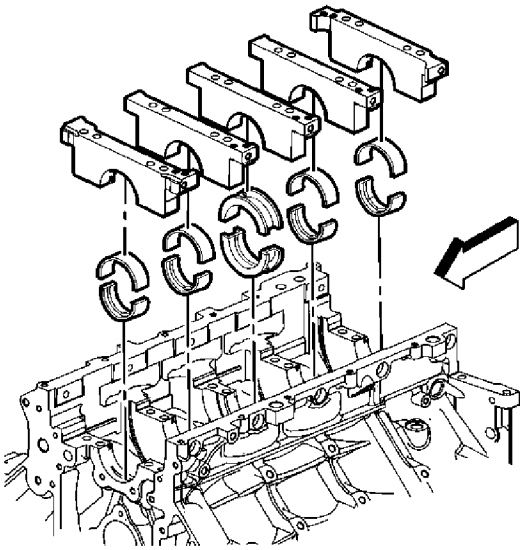


9. Remove the crankshaft.



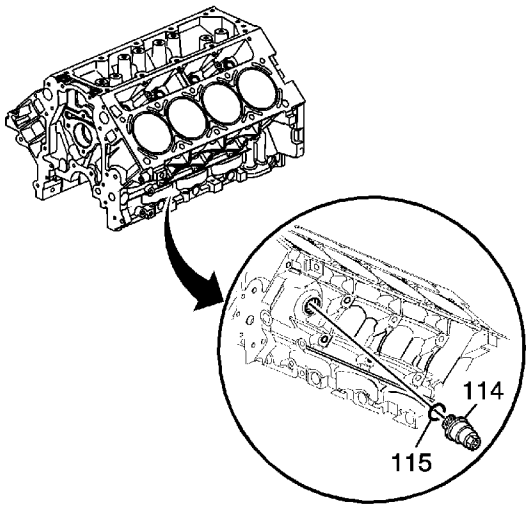
Note: Use care when handling the crankshaft. Avoid damage to the CKP sensor reluctor ring teeth. Nicks, burrs or other damage to the teeth may effect on-board diagnostics (OBD) II system performance.

10. Lay the crankshaft onto 2 wooden V-blocks or other protective surface.

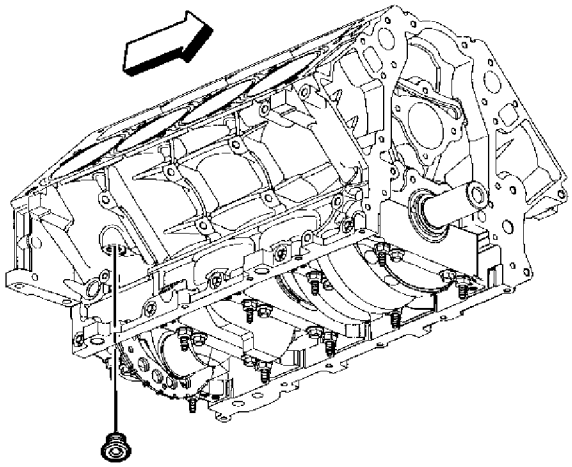


11. Remove the crankshaft bearings from the bearing caps and the engine block.
12. Mark, sort, or organize the crankshaft bearings so they may be installed to their original position and location. Refer to Separating Parts.

Engine Block Plug Removal



1. Remove the engine block coolant heater (114) and seal (115).



2. Remove the engine block right rear coolant drain hole plug and seal.

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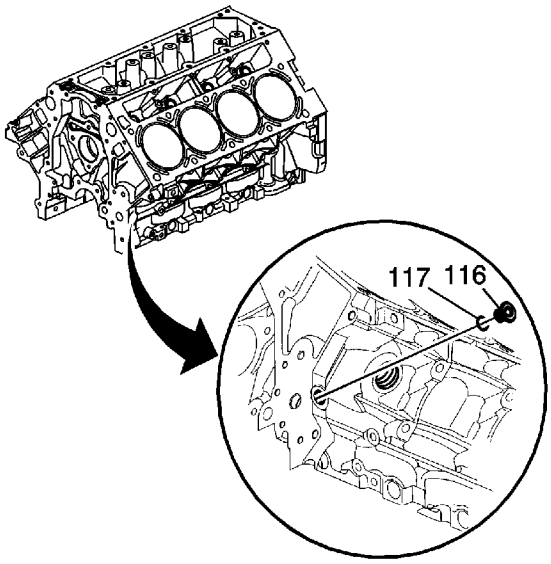
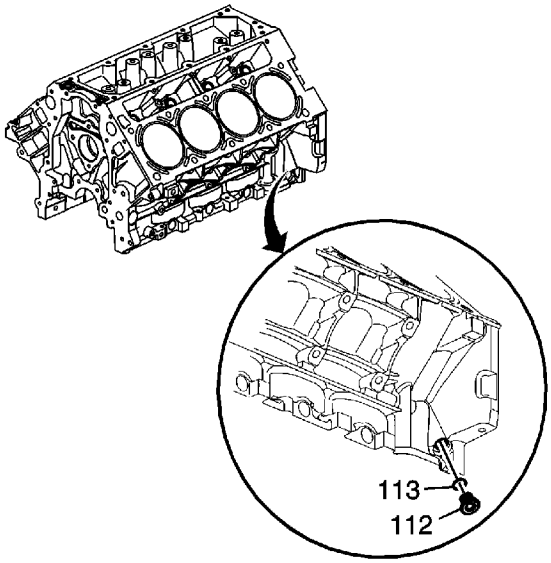
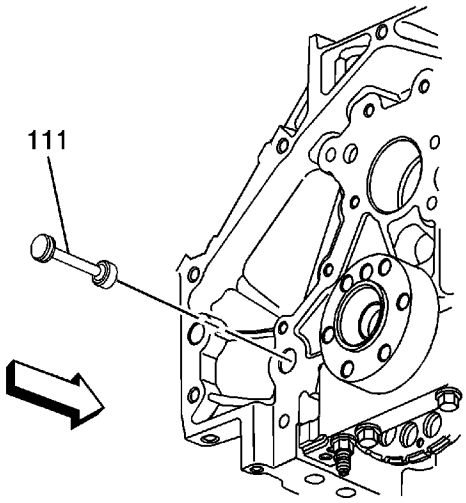


3. Remove the engine block left front oil gallery plug (116) and seal (117).



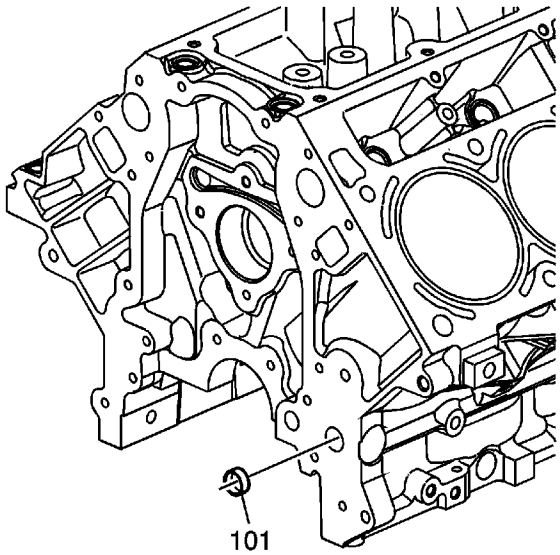
4. Remove the engine block left rear oil gallery plug (112) and seal (113).

   If the block plug and coolant heater sealing washers are not damaged, they may be used during assembly.



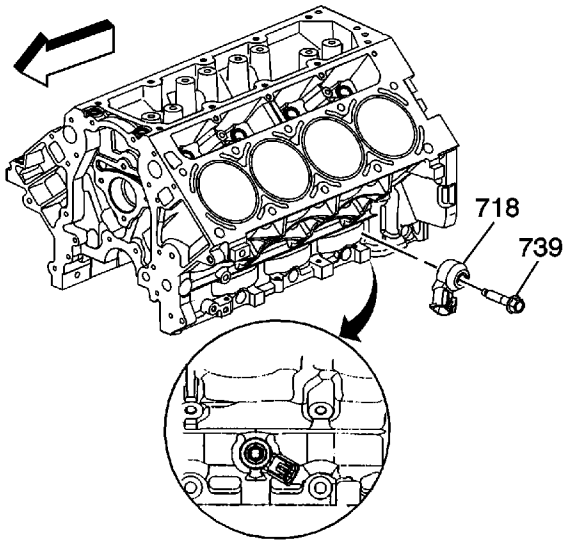
5. Remove the engine block rear oil gallery plug (111) and seal.
6. Inspect the O-ring seal of the rear oil gallery plug.

   If the O-ring seal is not cut or damaged, the plug and O-ring seal may be used during assembly.

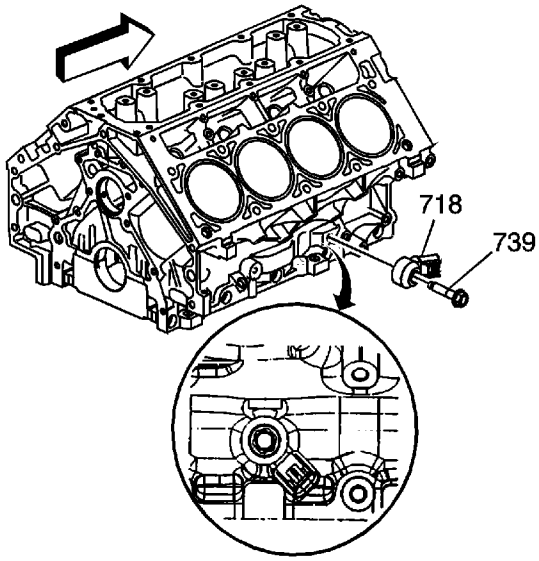


Important: Remove the front oil gallery plug, only if service is required. If the front oil gallery plug is removed, a NEW oil gallery plug must be installed.

7. Remove the engine block front oil gallery plug (101).



8. Remove the left side knock sensor (718) and bolt (739).



9. Remove the right side knock sensor (718) and bolt (739).

Engine Block Cleaning and Inspection

Special Tools

- *J 8087* Cylinder Bore Gauge
- *J 42385-100* Head/Main Bolt Thread Repair Kit

For equivalent regional tools, refer to Special Tools

Cleaning Procedure

Caution: Do not use a caustic solution to clean the aluminum engine block.

Note: When cleaning the engine block in a thermal type oven, do not exceed 232°C (450°F).

Clean the following components:

- Remove all sludge, dirt, or debris using a cleaning solvent or thermal type oven. Refer to Cleanliness and Care.
- Gasket surfaces

  Refer to Replacing Engine Gaskets.
- Coolant passages
- Oil galleries
- Main bearing caps
- Cylinder head bolt holes to remove threadlocking material

  Thread repair driver tool *J 42385-100* kit may be used to clean the threads of old threadlocking material.

Inspection Procedure

Inspect the following components:

- Cylinder walls for above acceptable scratches or gouging.
- Cylinder bores for above acceptable ring ridge at the top of the cylinder.
- Coolant jacket for cracks.
- Valve lifter bores for above acceptable scoring or wear.
- Crankshaft bearing webs for cracks.
- Gasket sealing surfaces for above acceptable scratches or gouging.

  Refer to Replacing Engine Gaskets.
- Oil galleries for restrictions.
- Threaded bolt holes for damaged threads.

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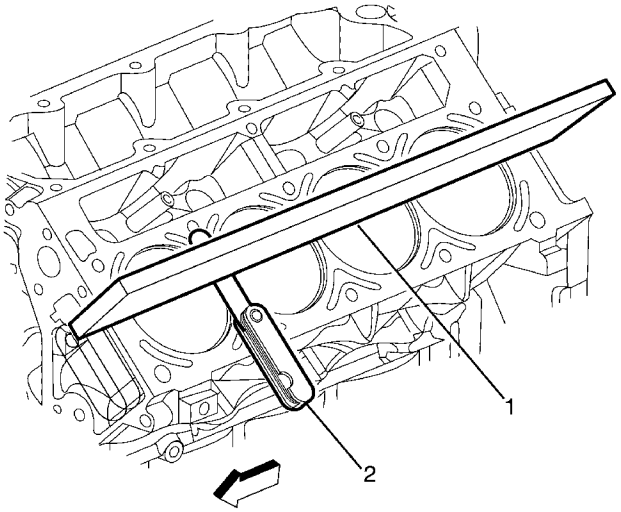
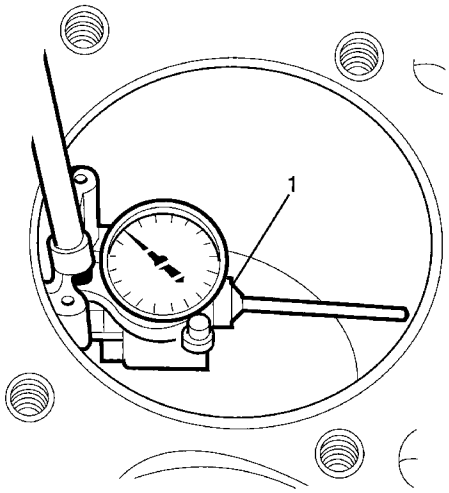
Measuring the Cylinder Deck for Distortion



1. Measure the cylinder block cylinder head deck using a straight edge (1) and feeler gauges (2).
2. Check the flatness of the cylinder block and cylinder head deck surfaces. If the measurement is not within specification, the cylinder block must be replaced. machining is not recommended. Refer to Engine Mechanical Specifications.

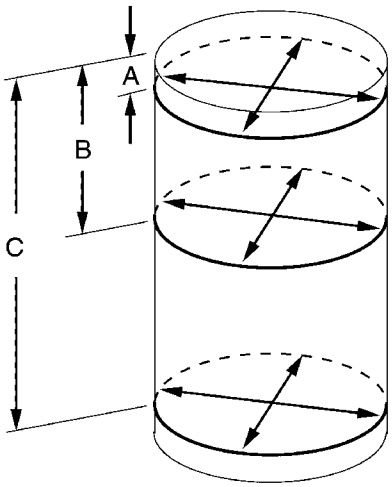
Measuring the Cylinder for Oversize

1. Adjust the micrometer to a dimension slightly smaller than the bore size. Refer to Engine Mechanical Specifications.



2. Insert the *J 8087* gauge (1) bore gauge into the micrometer and zero the bore gauge dial.
3. Using the *J 8087* gauge (1), measure the cylinder bore for oversize.

   Slide the bore gauge up and down throughout the length of the cylinder bore. Check the bore both parallel and perpendicular to the centre line of the crankshaft. A cylinder bore that exceeds the maximum diameter must be serviced with an oversized piston. Refer to Engine Mechanical Specifications.



4. Measure the bore at points (A, B and C), measure at these points both in line with and perpendicular to the crankshaft centre line.
   - Point (A) is 9 mm from the cylinder head surfaces
   - Point (B) is 57 mm from the cylinder head surfaces
   - Point (C) is 127 mm from the cylinder head surfaces
5. Calculate the difference between the two measurements at each location, the results will indicate any out of round bore condition. A cylinder bore that exceeds the maximum out of round condition must be serviced with an oversized piston. Refer to Engine Mechanical Specifications.

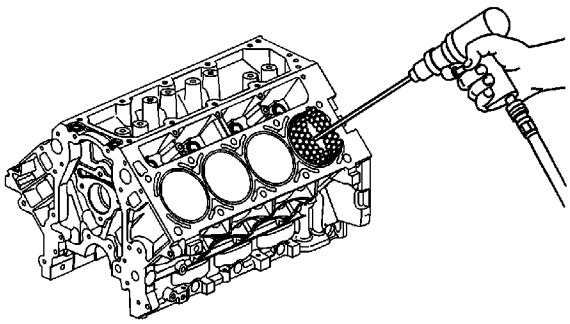
Cylinder Boring and Honing

Boring Procedure

Important: A 0.5 mm (0.02 in) oversize service piston and a piston ring set are available.

1. Measure all pistons with a micrometer to determine the cylinder bore diameter.
2. Before you use any type of boring bar, use a fine file and clean the top of the cylinder block, removing any dirt or burrs. If you do not check the cylinder block, the boring bar may be improperly positioned or tilted and the cylinder bore could be bored at an incorrect angle.
3. Carefully follow the instructions furnished by the manufacturer regarding use of the equipment.
4. When you bore the cylinders, ensure all the crankshaft bearing caps are in place. Tighten the crankshaft bearing caps to the proper torque in order to avoid distortion of the cylinder bores during final assembly.
5. When you take the final cut with a boring bar, leave 0.03 mm (0.001 in) on the cylinder bore diameter for the finish honing and fit of the piston.

Honing Procedure



1. When honing the cylinders, follow the manufacturer's recommendations for equipment use, cleaning, and lubrication. Use only clean, sharp stones of the proper grade for the amount of material you remove. Dull, dirty stones cut unevenly and generate excessive heat. Do not hone to final clearance with a coarse or medium-grade stone. Leave sufficient metal so that all stone marks may be removed with fine-grade stones. Perform final honing with a fine-grade stone, honing the cylinder to the proper clearance.
2. During the honing operation, thoroughly clean the cylinder bore. Repeatedly check the cylinder bore for fit with the selected piston.

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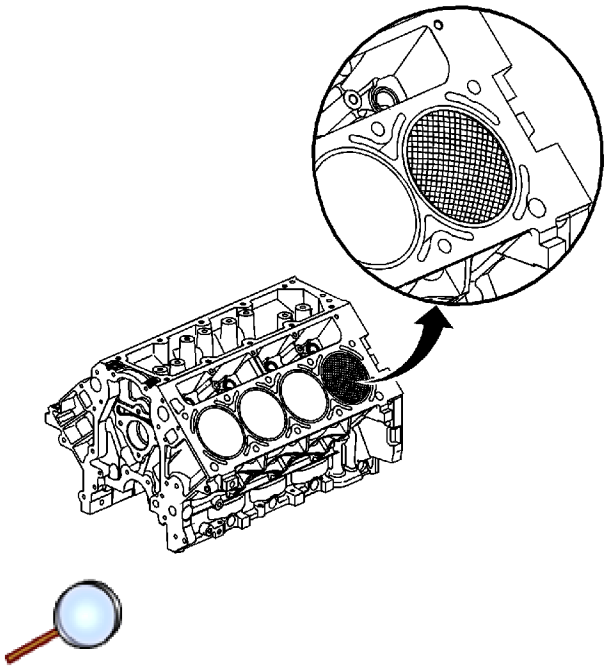
All measurements of the piston or the cylinder bore should be made with the components at normal room temperature.

3. When honing a cylinder for fit to an oversize piston, first perform the preliminary honing with a 100-grit stone.
4. Perform final cylinder honing with a 240-grit stone and obtain a 45 degree cross hatch pattern.

   A 240-grit stone is preferred for final honing. If a 240-grit stone is not available, a 220-grit stone may be used as a substitute.

5. The finish marks should be clean but not sharp. The finish marks should also be free from imbedded particles and torn or folded metal.
6. By measuring the selected piston at the sizing point and by adding the average of the clearance specification, you can determine the final cylinder honing dimension required.
7. After final honing and before the piston is checked for fit, clean the cylinder bores with hot water and detergent. Scrub the bores with a stiff bristle brush and rinse the bores thoroughly with hot water. Do not allow any abrasive material to remain in the cylinder bores. This abrasive material may cause premature wear of the new piston rings and the cylinder bores. Abrasive material will also contaminate the engine oil and may cause premature wear of the bearings. After washing the cylinder bore, dry the bore with a clean rag.
8. Perform final measurements of the piston and the cylinder bore.
9. Permanently mark the top of the piston for the specific cylinder to which it has been fitted.
10. Apply clean engine oil to each cylinder bore in order to prevent rusting.

Deglazing Procedure



Using a ball type or self centering honing tool, deglaze the cylinder bore lightly. Deglazing should be done only to remove any deposits that may have formed. Use a 240-grit stone of silicone carbide, or equivalent, material when performing the deglazing procedure.

A 240-grit stone is preferred for final honing. If a 240-grit stone is not available, a 220-grit stone may be used as a substitute.

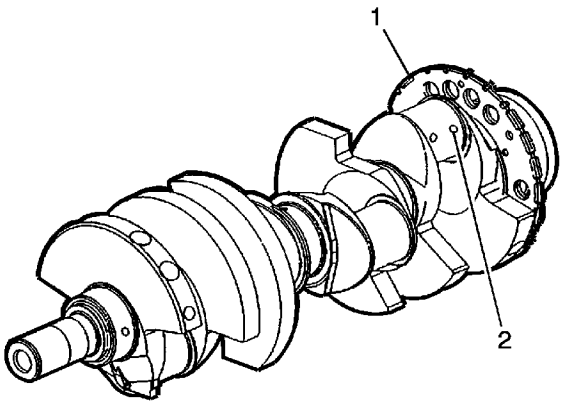
Crankshaft and Bearing Cleaning and Inspection

Special Tools

- *J 7872* Magnetic Base Dial Indicator Set
- *J 43690* Rod Bearing Checking Tool
- *J 43690-100* Rod Bearing Checking Tool - Adapter Kit

For equivalent regional tools, refer to Special Tools.

Cleaning Procedure



Note: Use care when handling the crankshaft. Avoid damage to the bearing surfaces or the lobes of the crankshaft position (CKP) reluctor ring. Damage to the teeth of the CKP reluctor ring may affect on-board diagnostics (OBD) II system performance.

1. Clean the crankshaft with solvent.
2. Thoroughly clean all oil passages (2) and inspect for restrictions or burrs.

Warning: Refer to Safety Glasses Warning in the Preface section.

3. Dry the crankshaft with compressed air.

Inspection Procedure

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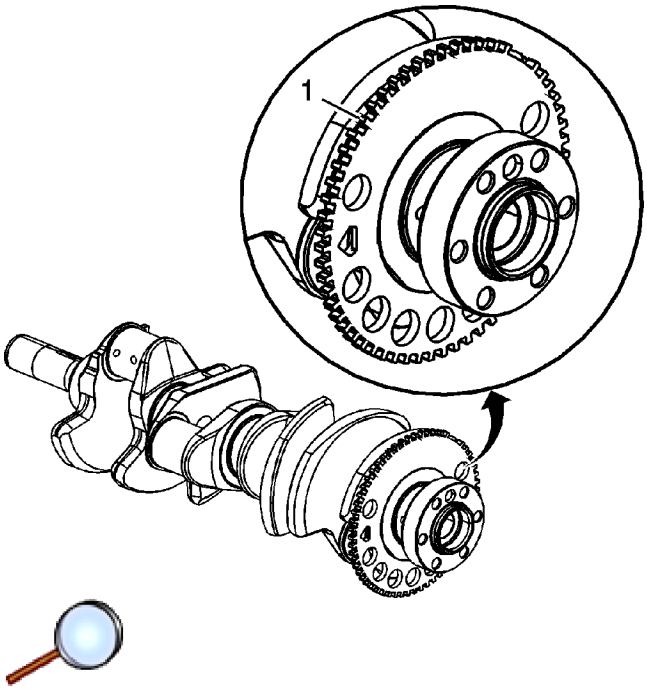
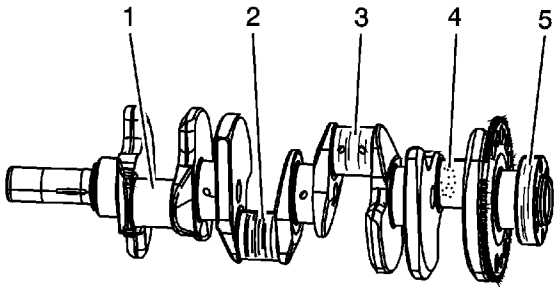


Note: The reluctor ring teeth should not have imperfections on the rising or falling edges. Imperfections of the reluctor ring teeth may affect OBD II system performance.

1. Inspect the CKP reluctor ring teeth (1) for damage.

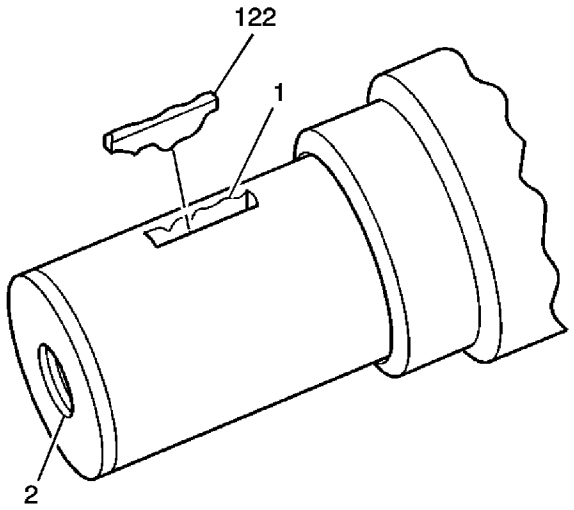


2. Inspect the crankshaft journals for wear.

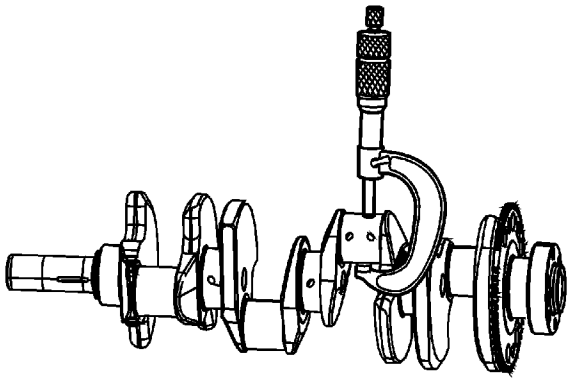
   Journals should be smooth (1) with no signs of scoring, wear, or damage.

3. Inspect the crankshaft journals for grooves or scoring (2).
4. Inspect the crankshaft journals for scratches or wear (3).
5. Inspect the crankshaft journals for pitting or imbedded bearing material (4).

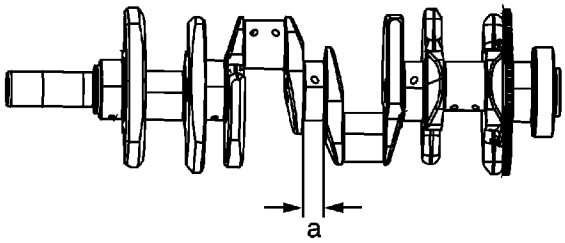
6. Inspect the crankshaft rear oil seal surface (5) for grooves or scoring.



7. Inspect the crankshaft key (122), keyway (1), and threaded hole (2) for damage.

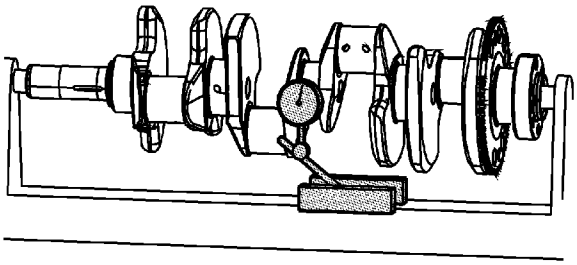


8. Measure the connecting rod journals for out-of-round and taper.



9. Measure the crankshaft thrust wall width.

   A crankshaft with a thrust wall width in excess of 26.2 mm (1.0315 in) (a) must be replaced.



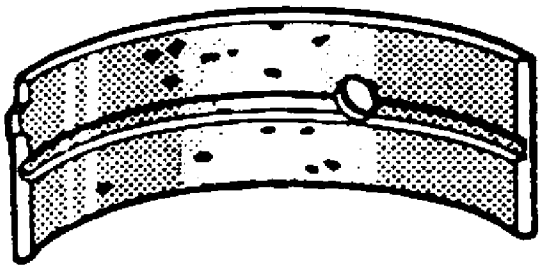
10. Measure the crankshaft runout.

    Use wooden V-blocks or a fixture to support the crankshaft on the front and rear journals.

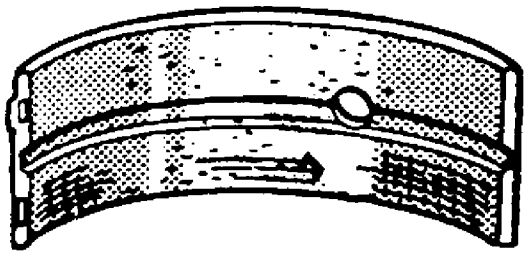
11. Use the *J 7872* dial indicator set in order to measure the crankshaft runout at the front and rear intermediate journals.
12. Use the *J 7872* dial indicator set in order to measure the runout of the crankshaft rear flange.
13. Use the *J 7872* dial indicator set in order to measure the runout of the crankshaft position

reluctor ring. Reluctor ring runout should be measured **1.0 mm (0.04 in)** below the ring teeth.

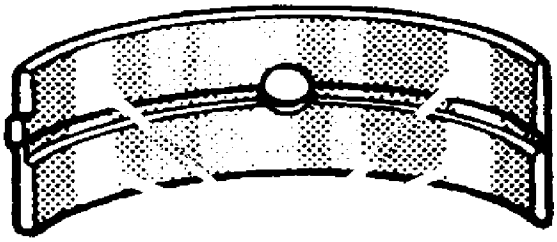
If the reluctor ring has runout in excess of **0.7 mm (0.028 in)** , replace the crankshaft.



14. Inspect crankshaft bearings for craters or pockets. Flattened sections on the bearing halves also indicate fatigue.



15. Inspect the crankshaft bearings for excessive scoring or discoloration.
16. Inspect the crankshaft bearings for dirt or debris imbedded into the bearing material.

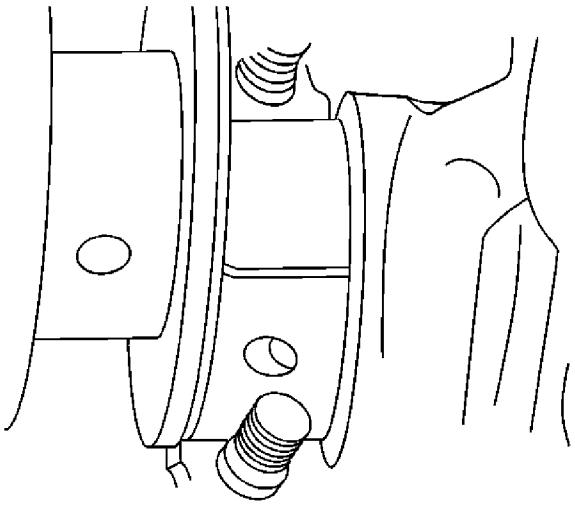


17. Inspect the crankshaft bearings for improper seating, indicated by bright, polished sections of the bearing.

    If the lower half of the bearing is worn or damaged, both upper and lower halves should be replaced.

    Generally, if the lower half is suitable for use, the upper half should also be suitable for use.

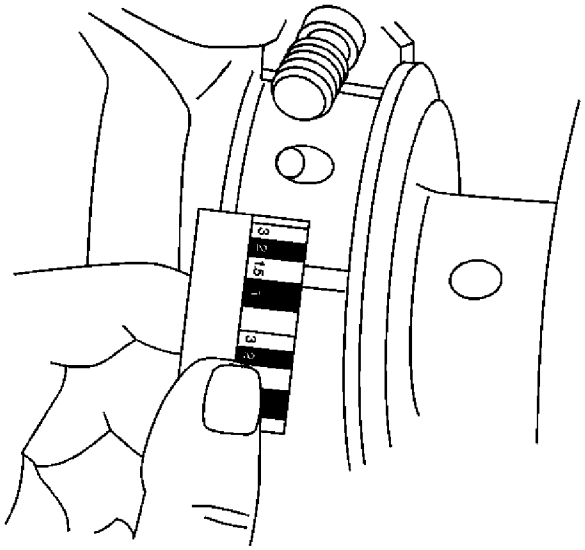
Measuring Main Bearing Clearance - Gaging Plastic Method



Note:

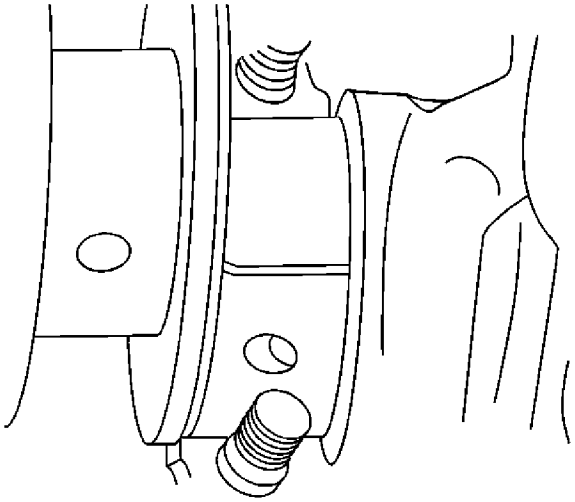
- The crankshaft main bearings are a precision insert type. Main bearing caps are machined with the engine block, for proper clearance, and cannot be shimmed or filed for bearing fit. If the clearances are found to be excessive, new bearings and/or engine block and cap repair or replacement may be required.
- Do not rotate the crankshaft while gaging plastic is between the crankshaft journal and the bearing surface.
- The crankshaft bearing clearances are critical. Excessive bearing clearance may affect crankshaft position sensor signals and may affect OBD II system operation.
- Remove the bearing cap side bolts prior to cap removal.

1. Remove the bearing caps, bearing half, and bolts. Refer to Crankshaft and Bearing Removal.
2. Install gaging plastic onto the crankshaft journal. Install the gaging plastic the full width of the crankshaft bearing journal.
3. Install the bearing caps, bearing half, and bolts. Refer to Crankshaft and Bearing Installation.
4. Remove the bearing caps, bearing half, and bolts. Refer to Crankshaft and Bearing Removal.



5. Using the scale supplied with the plastic gaging kit, measure the gaging plastic at its widest area.
   - If the gaging plastic shows irregularity in the journal, exceeding **0.025 mm (0.001 in)** , remove the crankshaft and measure the journal with a micrometer.
   - If clearance cannot be brought to specifications, replace the crankshaft or engine block as required. Refer to Engine Mechanical Specifications.

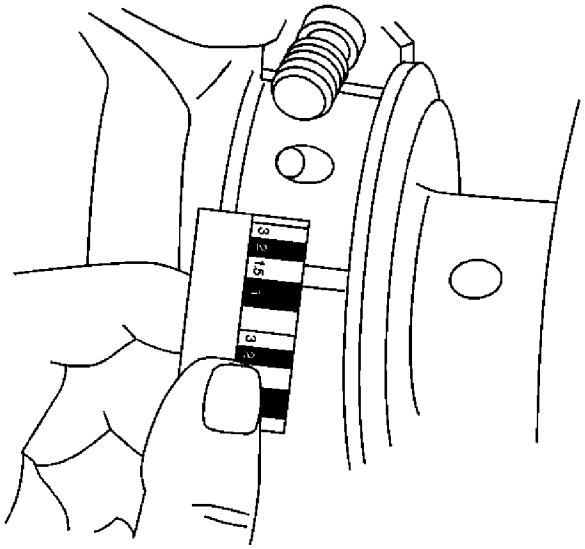
Measuring Connecting Rod Bearing Clearance - Gaging Plastic Method



Note:

- Connecting rod bearings are a precision insert type. Connecting rods are of a powdered metal design and cannot be shimmed or filed for bearing fit. If clearances are found to be excessive, a new bearing and/or connecting rod is required.
- Do not rotate the crankshaft while gaging plastic is between the crankshaft journal and the bearing surface.

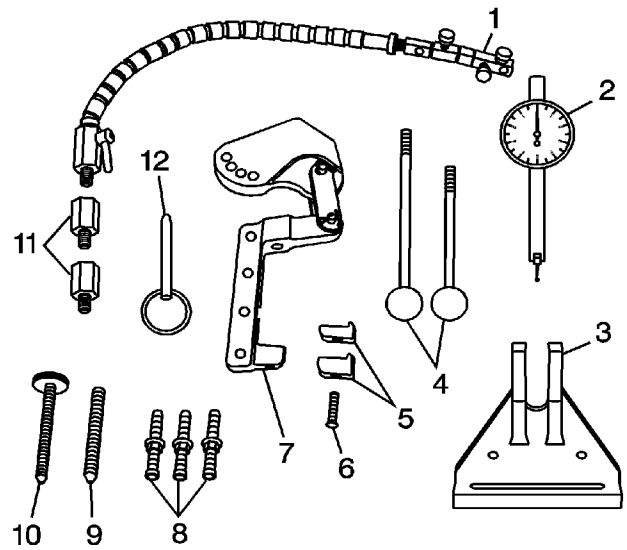
1. Remove the bearing cap, bearing half, and bolts. Refer to Piston, Connecting Rod, and Bearing Removal.
2. Install the gaging plastic onto the connecting rod bearing journal. Install the gaging plastic the full width of the journal.
3. Install the bearing cap, bearing half, and bolts. Refer to Piston, Connecting Rod, and Bearing Installation.
4. Remove the bearing cap, bearing half, and bolts. Refer to Piston, Connecting Rod, and Bearing Removal.



5. Using the scale supplied with the plastic gaging kit, measure the gaging plastic at its widest area. Refer to Engine Mechanical Specifications.

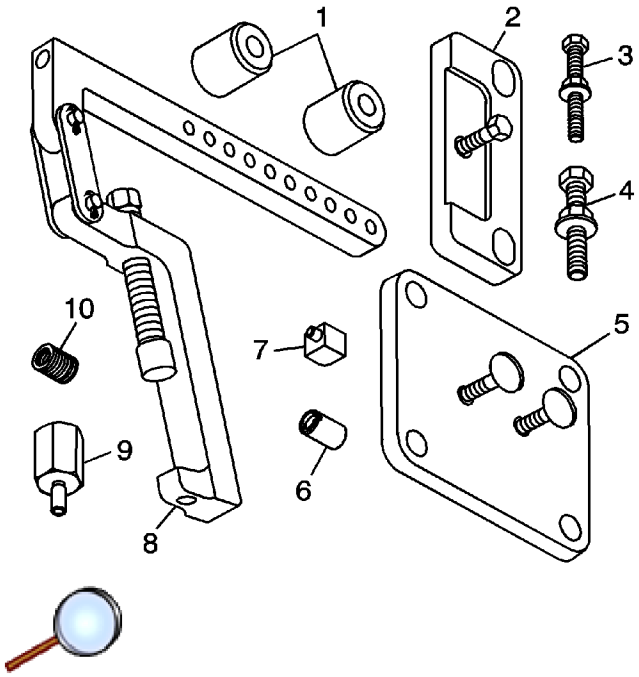
Measuring Connecting Rod Bearing Clearance - Using J 43690/J 43690-100

J 43690 rod bearing checking tool and *J 43690-100* adapter kit have been developed as a more accurate method to measure connecting rod bearing clearances. The instructions below provide an overview of tool set-up and usage. For more detailed information, refer to the tool instruction sheets supplied by the tool manufacturer.



J 43690 Rod Bearing Checking Tool

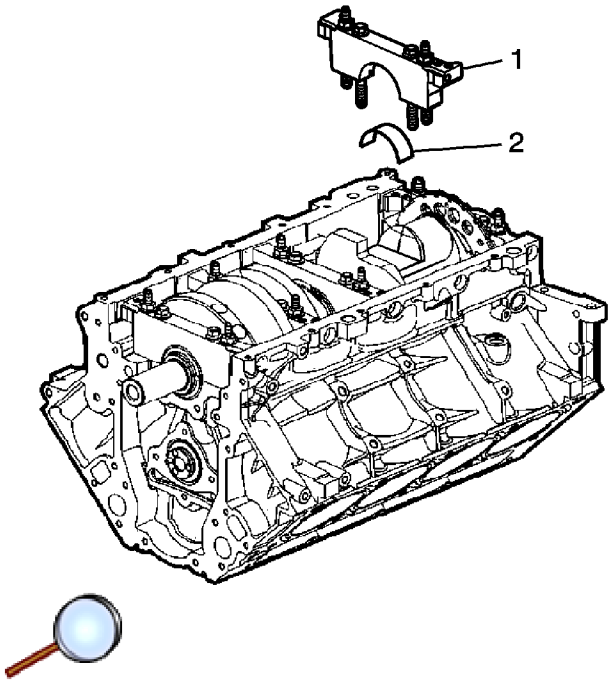
- J 43690-20 Swivel Base (1)
- J 43690-19 Dial Indicator (2)
- J 43690-2 Base (3)
- J 43690-5, J 43690-6 Handle (4)
- J 43690-10, J 43690-11 Foot (5)
- 280307 Screw (6)
- J 43690-1 Pivot Arm Assembly (7)
- J 43690-3, J 43690-7, J 43690-8 Screws (8)
- 280319 Screw (9)
- 280311 Screw (10)
- J 43690-17, J 43690-18 Adapter (11)
- 280310 Pin (12)



J 43690-100 Rod Bearing Checking Tool - Adapter Kit

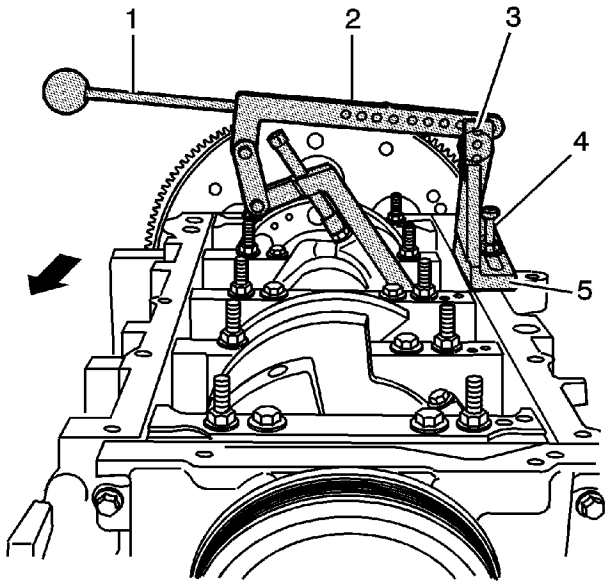
- J 43690-104 Spacer (1)
- J 43690-105 Retainer Plate (2)
- 505478 Bolt (3)
- 511341 Bolt (4)
- J 43690-106 Retainer Plate (5)
- J 43690-107 Cap (6)
- J 43690-102 Foot (7)
- J 43690-101 Pivot Arm Assembly (8)

- J 43690-103 Adapter (9)
- 505439 Adapter (10)

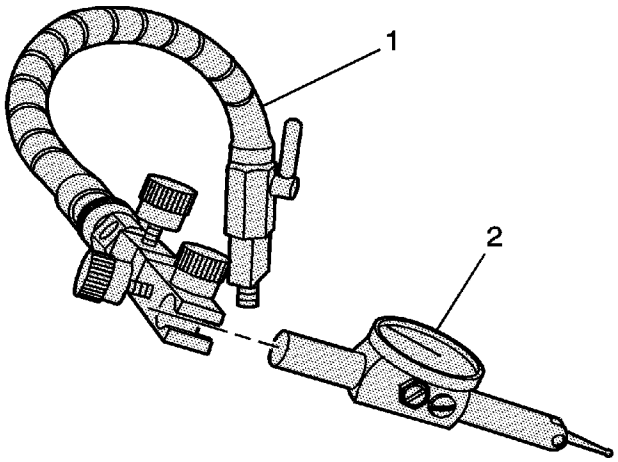


Note: The crankshaft must be secure, with no movement or rotation, in order to obtain an accurate reading.

1. Rotate the crankshaft until the journal/connecting rod to be measured is in the 12 o'clock position.
2. Remove a bearing cap and bolts (1).
3. Remove the bearing half (2).
4. Insert a piece of paper card stock onto the crankshaft journal.
5. Install the bearing half (2) and cap and bolts (1). Refer to Fastener Tightening Specifications.



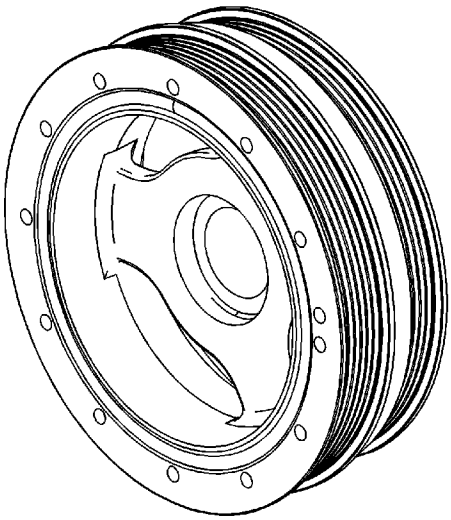
6. Install the following:
   6.1. J 43690-2 (5)
   6.2. J 43690-3 (4)
   6.3. J 43690-101 (2)
   6.4. 280310 (3)
   6.5. J 43690-5 (1)



7. Install the swivel base (1) and dial indicator (2).
8. Adjust per the manufacturers instructions and measure the connecting rod bearing clearance.

   A connecting rod with a clearance in excess of **0.076 mm (0.003 in)** is considered excessive. Service components, as required.

Crankshaft Balancer Cleaning and Inspection (6.2L LS3)



1. Clean the crankshaft balancer in solvent.
2. Using a wire brush, clean the belt grooves of all dirt and debris.
3. Dry the crankshaft balancer with compressed air.
4. Inspect the crankshaft balancer for the following conditions:
   - Worn, grooved, or damaged hub seal surface
   - A crankshaft balancer hub seal surface with excessive scoring, grooves, rust or other damage must be replaced.
   - Minor imperfections on the hub seal surface may be removed with polishing compound or fine grade emery cloth.

Note: In order for the belt to track properly, the belt grooves should be free of all dirt and debris.

   - Dirty or damaged belt grooves
   - The balancer belt grooves should be free of any nicks, gouges, or other damage that may not allow the belt to track properly.
   - Minor imperfections may be removed with a fine file.
   - Worn, chunking or deteriorated rubber between the hub and pulley

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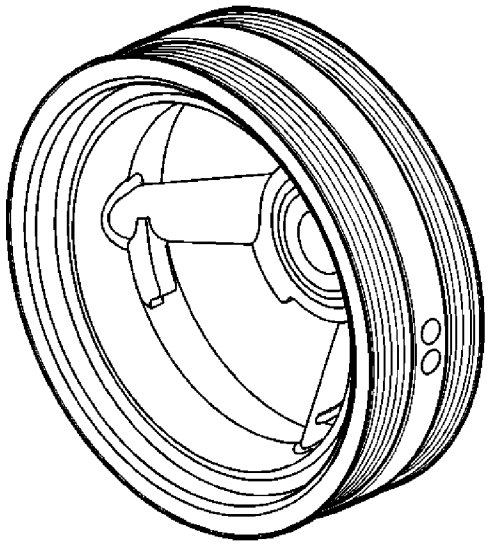
Crankshaft Balancer Cleaning and Inspection (L76)



1. Clean the crankshaft balancer in solvent.
2. Clean the belt grooves of all dirt or debris with a wire brush.
3. Dry the crankshaft balancer with compressed air.
4. Inspect the crankshaft balancer for the following conditions:
   - Worn, grooved, or damaged hub seal surface
   - A crankshaft balancer hub seal surface with excessive scoring, grooves, rust or other damage must be replaced.
   - Minor imperfections on the hub seal surface may be removed with polishing compound or fine grade emery cloth.

   Note: In order for the belt to track properly, the belt grooves should be free of all dirt or debris.

   - Dirty or damaged belt grooves
   - The balancer belt grooves should be free of any nicks, gouges, or other damage that may not allow the belt to track properly.
   - Minor imperfections may be removed with a fine file.
   - Worn, chunking, or deteriorated rubber between the hub and pulley

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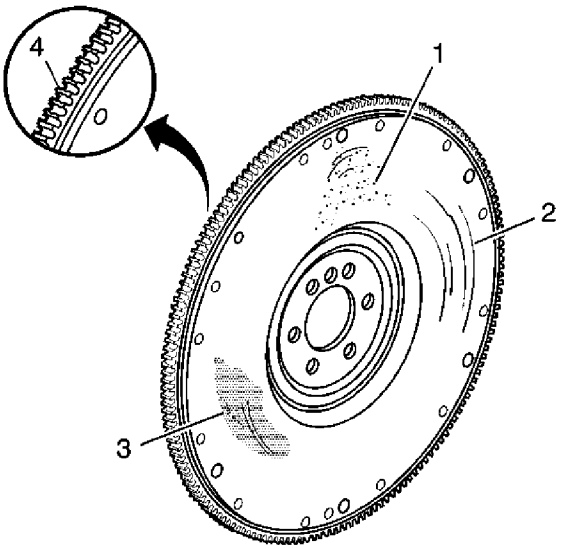
Engine Flywheel Cleaning and Inspection



Note: In order to maintain the proper component balance, contact surface taper, and heat transfer, manual transmission flywheels are NOT to be machined.

Inspect the manual transmission flywheel for the following conditions:

- Pitted surface (1)
- Grooved or scored surface (2)
- Rusted surface (3)
- Damaged ring gear teeth (4)
- Loose or improperly positioned ring gear

  The ring gear has an interference fit onto the flywheel and should be positioned completely against the flange of the flywheel.
- Missing, bent or damaged pressure plate locating pins

  The 2 locating pins are installed into the flywheel and spaced 170 degrees apart to ensure proper orientation of the clutch pressure plate to the engine flywheel during assembly.

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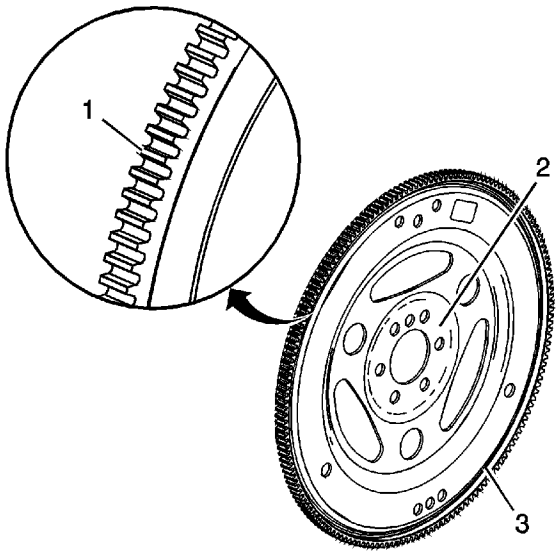
Automatic Transmission Flex Plate Cleaning and Inspection



1. Clean the flex plate in solvent.

   Warning: Refer to Safety Glasses and Compressed Air Warning in the Preface section.

2. Dry the flex plate with compressed air.
3. Inspect the flex plate for the following conditions:
   - Damaged ring gear teeth (1)
   - Stress cracks around the flex plate-to-crankshaft bolt hole locations (2)

     Note: Do not attempt to repair the welded areas that retain the ring gear to the flex plate. Install a new flex plate.

   - Welded areas (3) that retain the ring gear onto the flex plate for cracking

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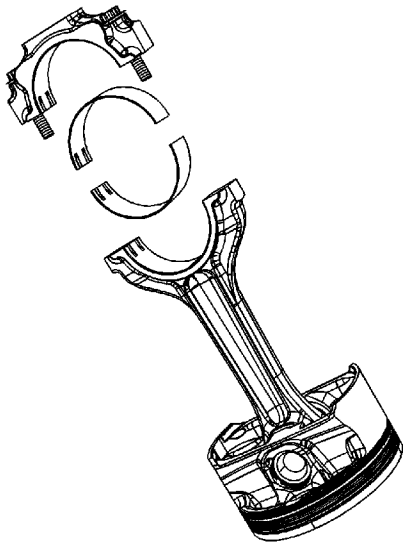
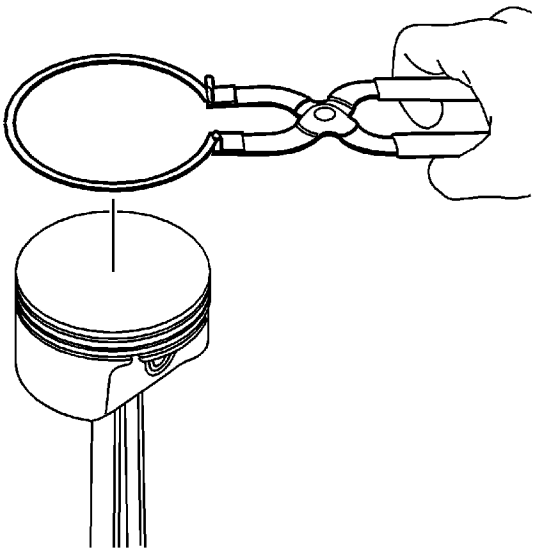
Piston and Connecting Rod Disassemble



1. Remove the connecting rod bearings from the rod and cap.



2. Using piston ring pliers, remove the piston rings from the piston.

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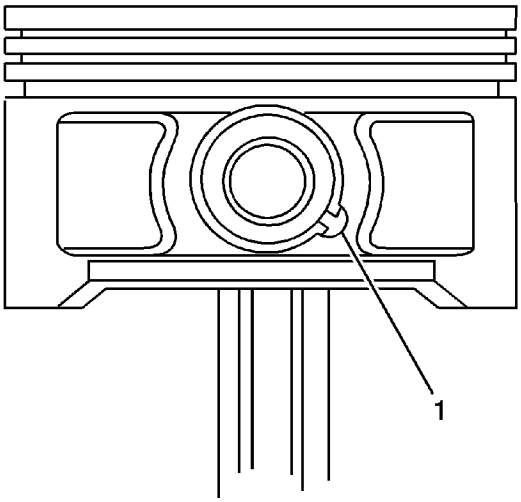
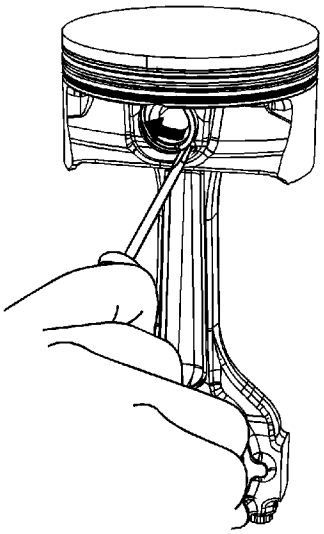
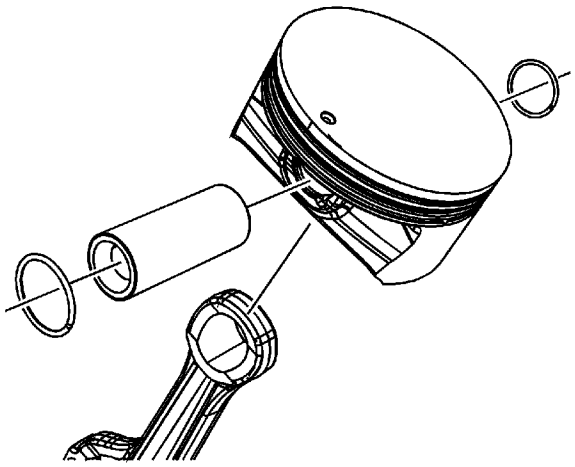


3. Rotate the piston pin retainers until the ring end gaps are positioned in the cutout area (1) of the pin bore.



4. Remove the retainers starting in the cutout area of the pin bore.

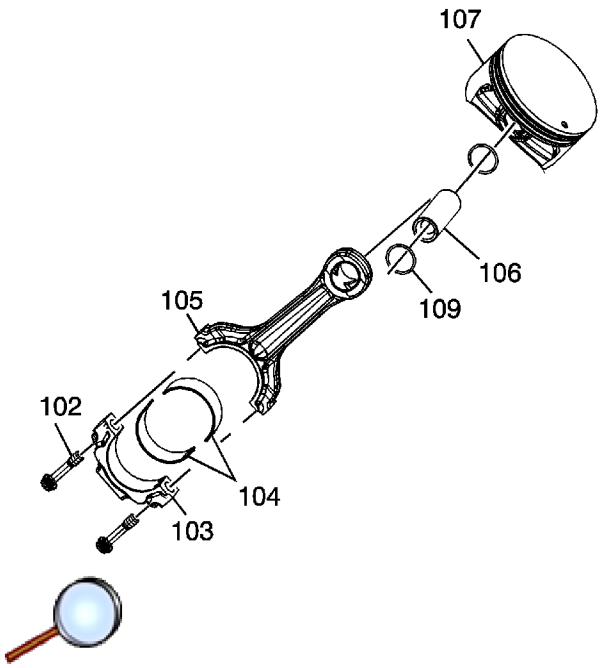


5. Remove the pin from the piston and connecting rod.
6. The piston and pin are a matched set and are not to be serviced separately.

   Mark, sort, or organize the piston and the matching piston pin.

Piston, Connecting Rod, and Bearing Cleaning and Inspection

Piston, Pin, and Piston Rings



Note:

- Replace pistons, pins, and connecting rods that are damaged or show signs of excessive wear.
- The piston and pin are to be serviced as an assembly.
- Do not wire brush any part of the piston.
- Measurement of the components should be taken with the components at normal room temperature.

1. Clean the varnish and carbon from the piston (107) using cleaning solvent.

   Warning: Refer to Safety Glasses and Compressed Air Warning in the Preface section.

2. Dry the components with compressed air.

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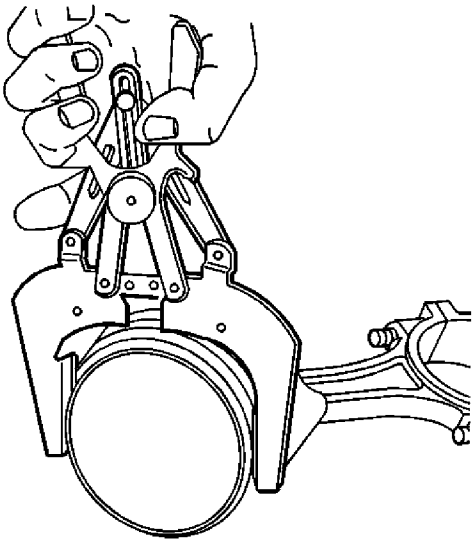
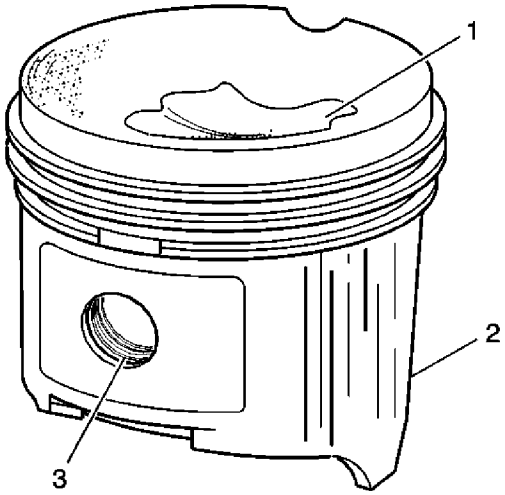
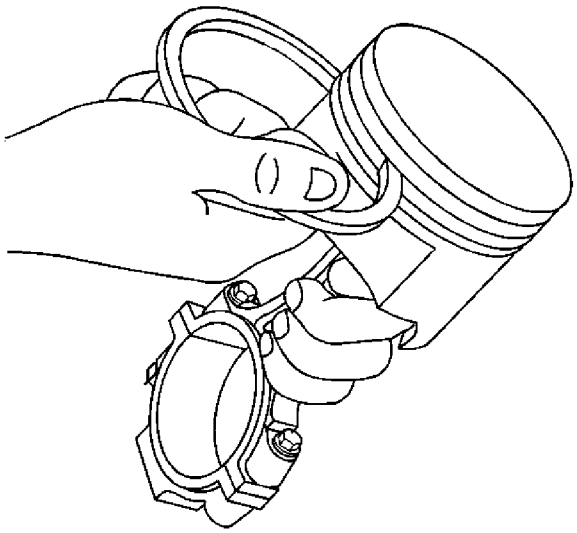


3. Clean the piston ring grooves with a suitable ring groove cleaning tool.
4. Clean the oil lubrication holes and slots.

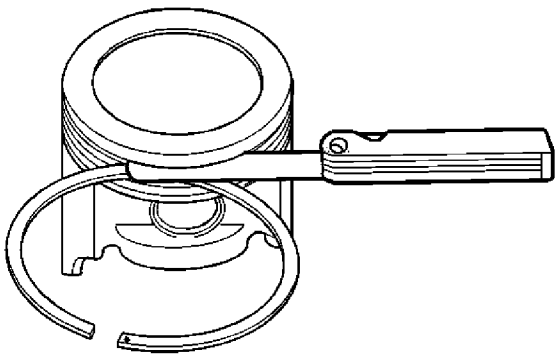


5. Inspect the piston for the following conditions:
   - Cracks in the piston ring lands, the piston skirt, or pin bosses
   - Piston ring grooves for nicks, burrs, or warpage which may cause the piston ring to bind
     MINOR imperfections may be removed from the piston with a fine file.
   - Eroded areas at the top of the piston (1)
   - Scuffed or damaged skirts (2)
   - Scoring to the piston pin bore (3) or piston pin

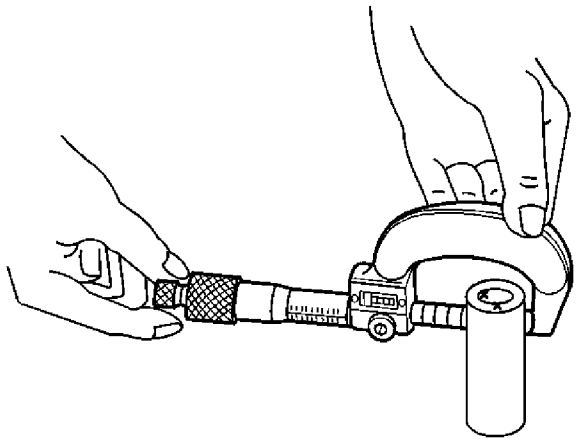


6. Insert the edge of the piston ring into the piston ring groove.

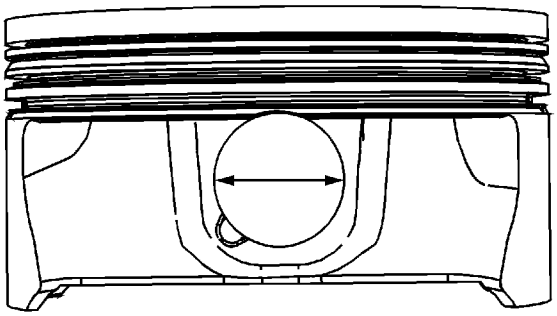
   Roll the piston ring completely around the piston. If binding is caused by a distorted ring groove, MINOR imperfections may be removed with a fine file. If binding is caused by a distorted piston ring, replace the rings, as required.



7. Measure the piston ring side clearance with a feeler gage. If side clearance is not within specifications, try another piston ring. If the proper ring-to-groove clearance cannot be obtained, replace the piston and pin as an assembly. Refer to Engine Mechanical Specifications.

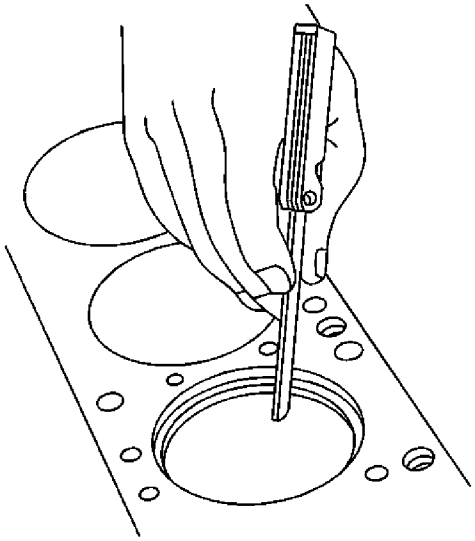


8. To determine piston pin-to-bore clearance, use a micrometer and measure the piston pin outside diameter (OD).



9. To determine the piston pin-to-bore clearance, use an inside micrometer and measure the piston pin bore inside diameter (ID).
10. Subtract the piston pin OD measurement from the piston pin bore ID measurement to determine pin-to-bore clearance. Refer to Engine Mechanical Specifications.

Measuring Piston Ring End Gap

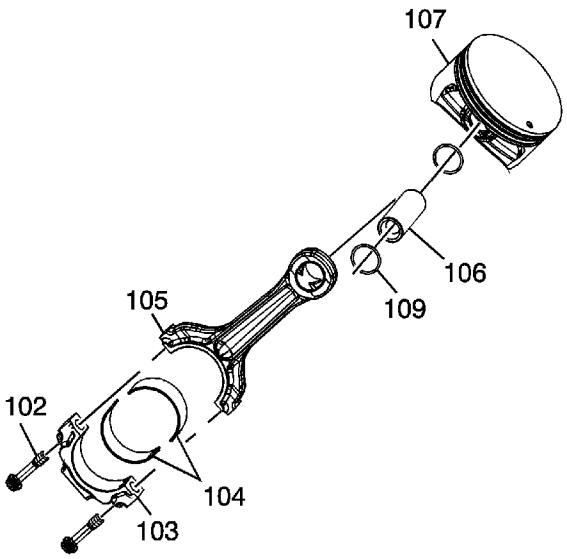


Note:

- Do not attempt to file the end of the piston ring to achieve the proper end gap clearance.
- Measure the piston ring in the cylinder in which it will be used.

1. Place the piston ring into the cylinder bore **6.5 mm (0.25 in)** below the top of the ring travel area. Both rings should be installed with the orientation marks facing the top of the piston.
2. Insert a feeler gage and measure the piston ring end gap. Refer to Engine Mechanical Specifications.

Connecting Rod and Bearings



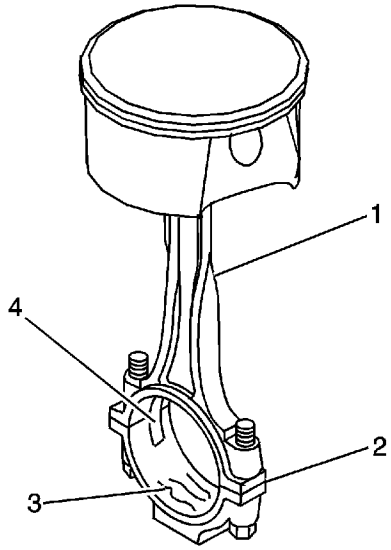
Note:

- The powdered metal connecting rod and cap are machined for proper clearances. The connecting rod and cap must be used as an assembly with no repair or modifications to either mating surface. Do not attempt to repair the rod or cap. If service is required, replace the rod and cap as an assembly.
- Do not attempt to repair the bolt hole threads of the connecting rod.

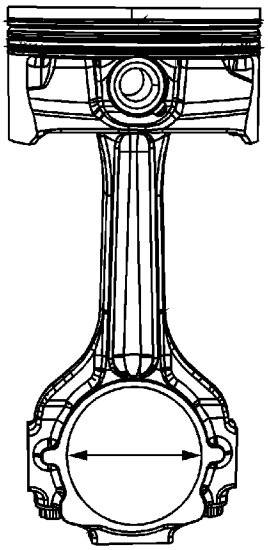
1. Clean the connecting rod (105) and cap (103) in solvent.

   Warning: Refer to Safety Glasses and Compressed Air Warning in the Preface section.

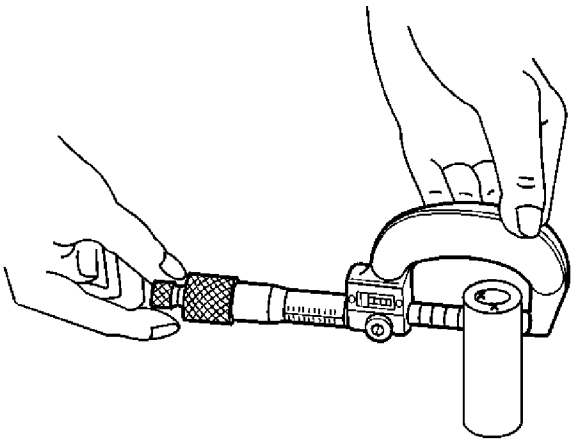
2. Dry the components with compressed air.



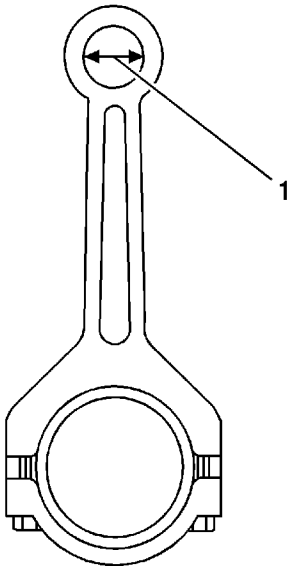
3. Inspect the connecting rod for the following conditions:
   - Twisting (1)
   - Proper fit of the connecting rod and cap mating surfaces (2)
   - Nicks or gouges in the bearing bore (3)
   - Damage to the bearing locating slots (4)



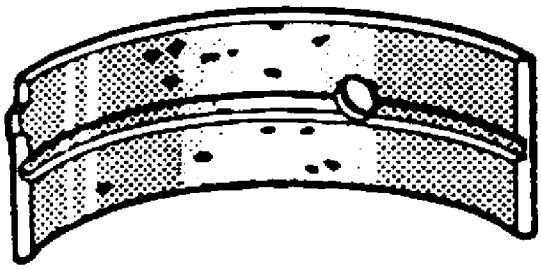
4. Measure the connecting rod bearing bore for an out-of-round condition. Refer to Engine Mechanical Specifications.



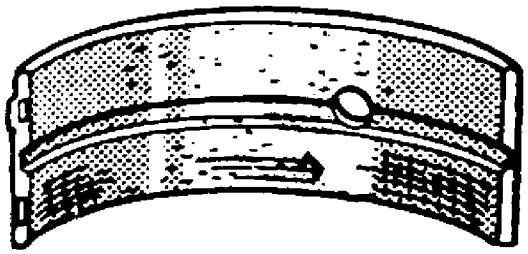
5. To determine piston pin-to-connecting rod bore clearance, use a micrometer and measure the piston pin OD.



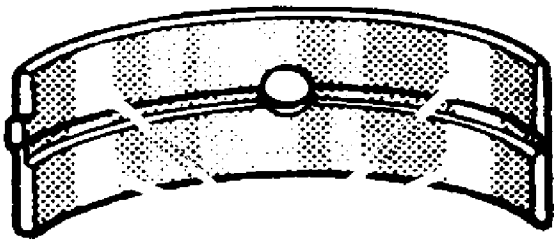
6. To determine the piston pin-to-connecting rod bore clearance, use a micrometer and measure the connecting rod pin bore (1) ID.
7. Subtract the piston pin OD measurement from the connecting rod pin bore ID measurement to determine pin-to-bore clearance. Refer to Engine Mechanical Specifications.



8. Inspect the connecting rod bearings for craters or pockets. Flattened sections on the bearing halves indicate fatigue.



9. Inspect the connecting rod bearings for excessive scoring or discoloration.
10. Inspect the connecting rod bearings for dirt or debris imbedded into the bearing material.



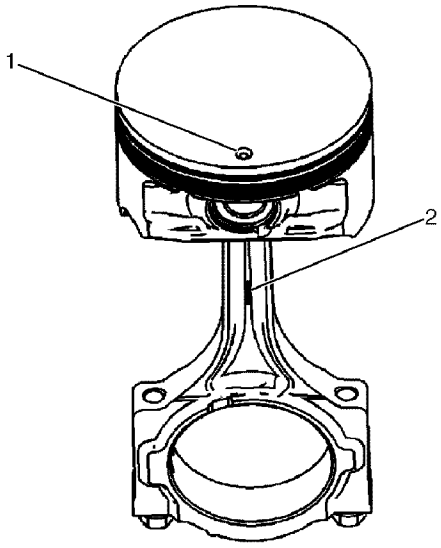
11. Inspect the connecting rod bearings for improper seating indicated by bright, polished sections of the bearing surface.
12. To determine the piston pin-to-bore clearance, use an inside micrometer and measure the piston pin bore ID.
13. Subtract the piston pin OD measurement from the piston pin bore ID measurement to determine pin-to-bore clearance. Refer to Engine Mechanical Specifications.

Piston and Connecting Rod Assemble

Tools Required

EN 46121 Connecting Rod Guide Pin Set

Piston and Piston Pin Installation Procedure



1. Assemble the piston and connecting rod with the notch (1) on the piston and the painted mark (2) on the connecting rod facing the front of the engine.

   When installing the piston and connecting rod assembly, the mark on the top of the piston (1) and the painted mark (2) on the connecting rod should face the front of the engine.

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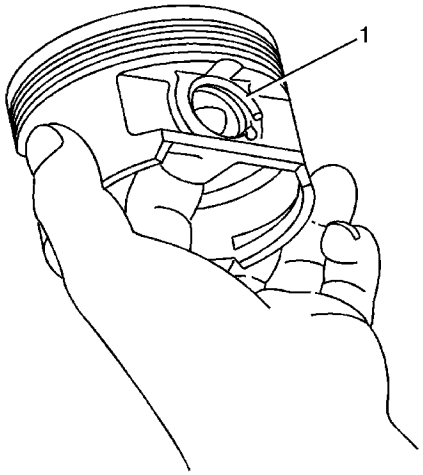
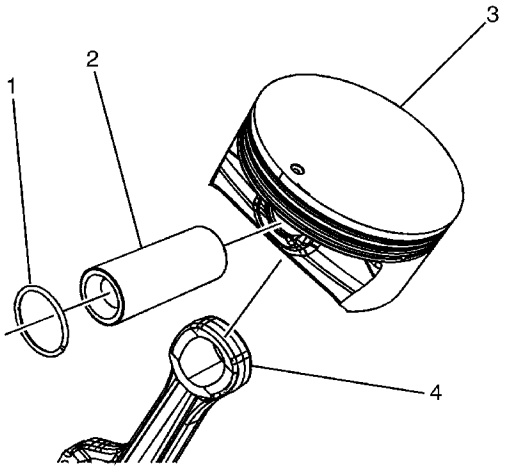


Important: Make sure the retainer (1) is seated in the groove.

2. Install the retainer (1).

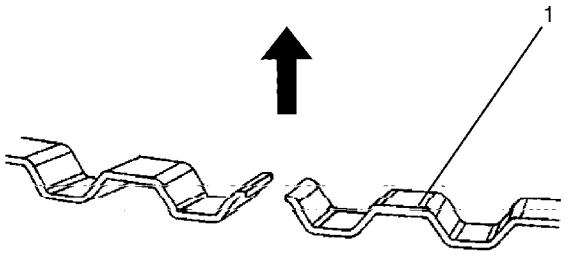


3. Install the piston pin (2) to the piston (3) and connecting rod (4).

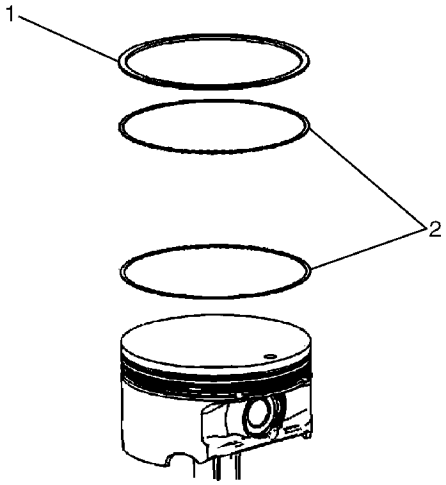
Important: Make sure the retainer (1) is seated in the groove.

4. Install the retainer (1).

Piston Ring Installation Procedure



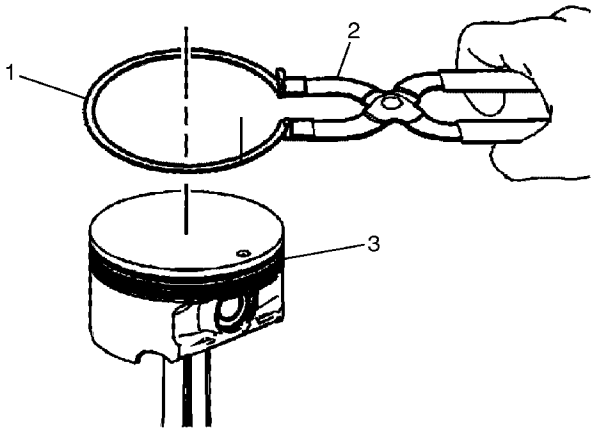
1. Correctly orient the oil control ring expander (1) as shown before installation. The ends of the oil control ring expander (1) must be facing toward the top of the piston.



2. Using a piston ring expander, install the oil control ring assembly using the following procedure:
   2.1. Install the expander ring (2).

Important: Make sure that you do not over expand the piston ring. Over expanding the piston rings will distort or crack the rings.

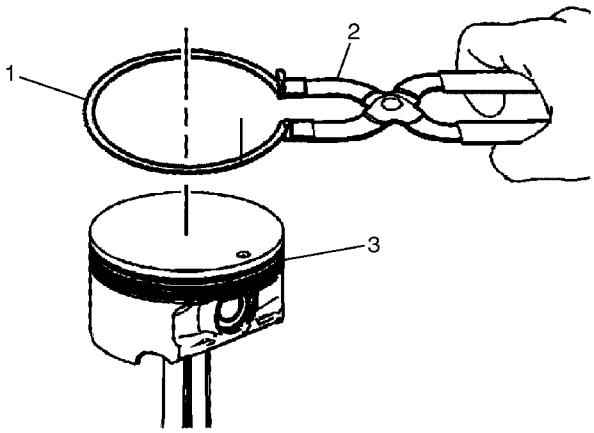
   2.2. Install the 2 oil scraper rings (1). Expand the rings only enough to clear the piston diameter.



Important: Make sure that you do not over expand the piston ring. Over expanding the piston rings will distort or crack the rings.

Important: Install the second piston ring (2) onto the piston (3) using the ring expander (1).

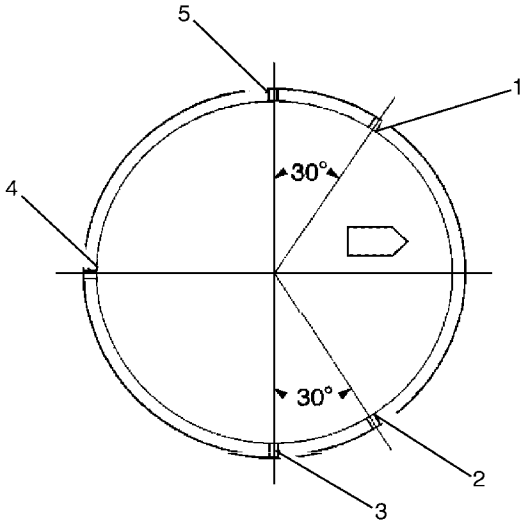
3. Install the second piston ring (2) onto the piston (3).



Important: Make sure that you do not over expand the piston ring. Over expanding the piston rings will distort or crack the rings.

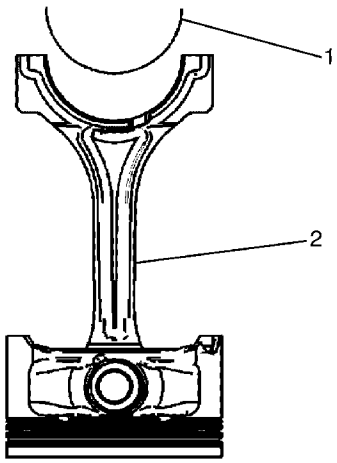
Important: Install the top piston ring (2) onto the piston (3) using the ring expander (1).

4. Install the top piston ring (2) onto the piston (3).



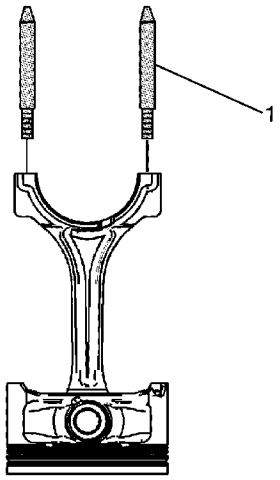
5. Once the rings are installed, set the ring gaps for the oil control, second and top ring as follows. Use the piston location arrow for reference.
   5.1. Lower oil control ring - position (1).
   5.2. Upper oil control ring - position (2).
   5.3. Top Ring - position (3).
   5.4. Oil control ring expander - position (4).
   5.5. Second ring - position (5).

Connecting Rod Bearing Installation Procedure

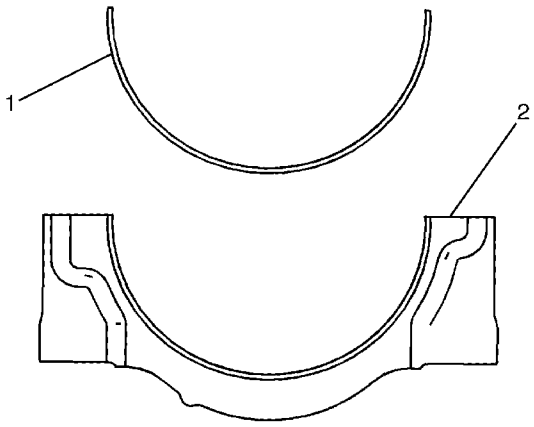


Important: If the connecting rod bearings (1) have been used in a running engine, you must replace them with NEW connecting rod bearings (1) for reassembly.

1. Clean the connecting rod (2) and the connecting rod cap bearing bore with a lint-free cloth.
2. Clean all the oil from behind the connecting rod bearing (1) halves.
3. Install new upper connecting rod bearings (1) into position. Roll the connecting rod bearings (1) into position so that the lock tang engages the alignment slot. The connecting rod bearings (1) must fit flush in the connecting rod (2).



4. Install the EN 46121 (1) into the connecting rod bolt holes.



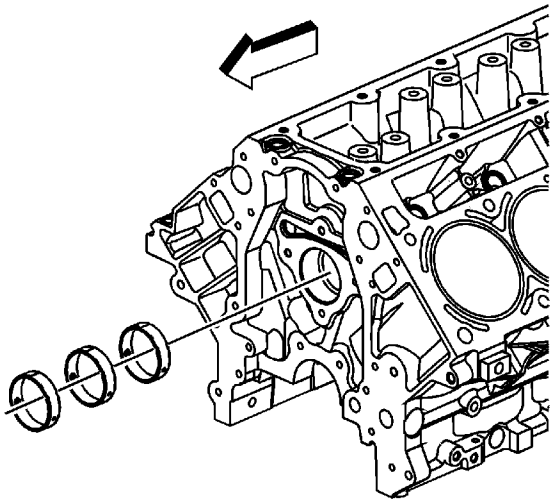
5. Install new lower connecting rod bearings (1) into position in the connecting rod cap (2). Roll

the connecting rod bearings (1) into position so that the lock tang engages the alignment slot. The bearings must fit flush with the connecting rod cap (2).

Camshaft Bearing Removal

Tools Required

J 33049 Camshaft Bearing Service Set



Important: A loose camshaft bearing may be caused by an enlarged, out of round, or damaged engine block bearing bore.

1. Prior to bearing removal, inspect the camshaft bearings for loose fit in the engine block bearing bores. Refer to Camshaft and Bearings Cleaning and Inspection.
2. Repair or replace the components, as required.

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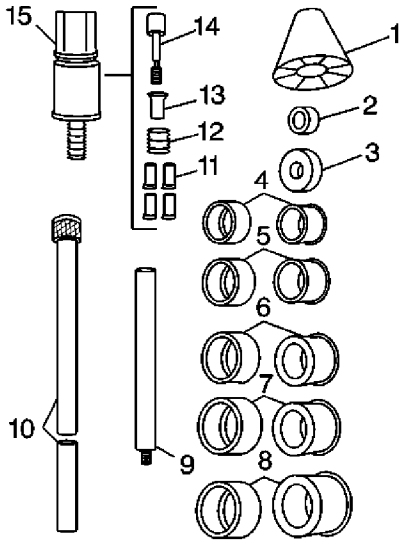
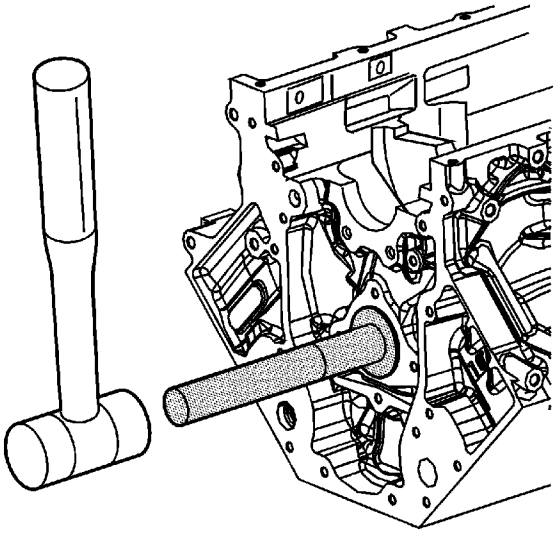


3. Select the expanding driver (4-8) and washer (2 or 3) from the J 33049 .
4. Assemble the tool.
5. Insert the tool through the front of the engine block and into the bearing.
6. Tighten the expander assembly (15) nut until snug.
7. Push the guide cone (1) into the front camshaft bearing in order to align the tool.



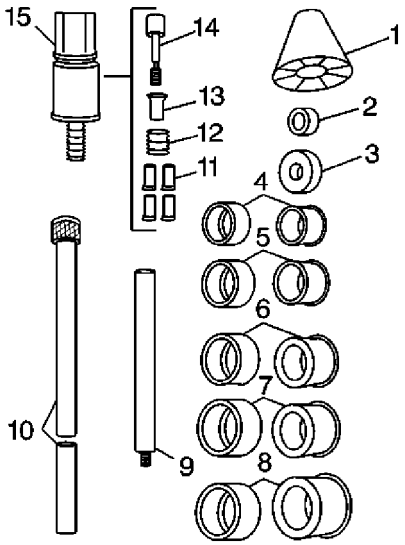
8. Drive the bearing from the block bore.

Important: In order to remove the front camshaft bearing, operate the tool from the rear of the block, using the guide cone in the rear camshaft bearing bore.

9. Repeat the above procedures in order to remove the remaining bearings.

Tool Usage Information

Bearing, Expander, and Expander Driver Information



- The tool consists of a guide cone (1), driving washers (2 or 3), expander bearing drivers (4-8), driver bars (9 or 10), expander jaws (11), expander sleeve (12), expander cone (13), expander shaft (14), and expander assembly (15).
- Expander bearing driver number 1 inside diameter is 28.575-37.465 mm (1.125-1.475 in) and is used with the expander assembly and the small washer.
- Expander bearing driver number 2 inside diameter is 37.465-43.18 mm (1.475-1.7 in) and is used with number 1 expanding driver and the small washer.
- Expander bearing driver number 3 inside diameter is 43.18-48.895 mm (1.7-1.925 in) and is used with number 2 expanding driver and the large washer.
- Expander bearing driver number 4 inside diameter is 48.895-54.61 mm (1.925-2.15 in) and is used with number 3 expanding driver and the large washer.
- Expander bearing driver number 5 inside diameter is 54.61-60.325 mm (2.150-2.375 in) and is used with number 4 expanding driver and the large washer.
- Expander bearing driver number 6 inside diameter is 60.325-68.326 mm (2.375-2.69 in) and is used with number 5 expanding driver and the large washer.

Tool Assembly and Operation

1. Select the proper expanding driver and washer from the expanding driver and washer information.

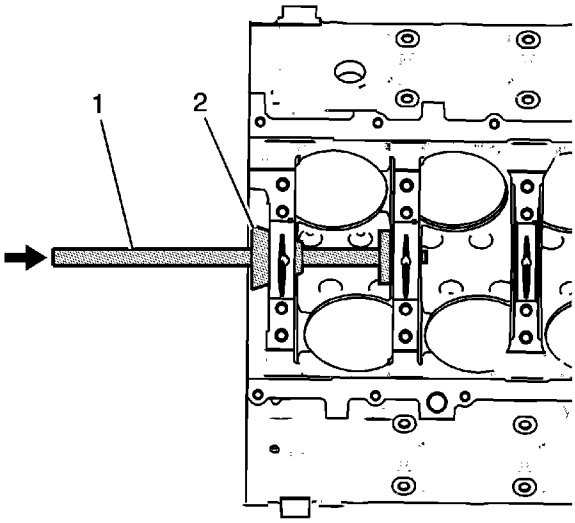
   Important: To install or remove the expanding driver, always push on or pull from the ends.

   Pressure on the outside diameter may cause a bind against the rubber expanding sleeve.

2. Place the expanding driver onto the expander assembly.
3. Ensure the separation lines between the segments of the expanding driver align with the separation lines of the expander assembly.

4. With the small end of the cone facing the driver assembly, place the guide cone over the driving bar.
5. Place the driving washer over the threaded portion of the expander assembly.
6. Screw the expander assembly, with driving washer, onto the driving bar.

   For removal of the inner bearings, it may be necessary to install the driver bar extension.

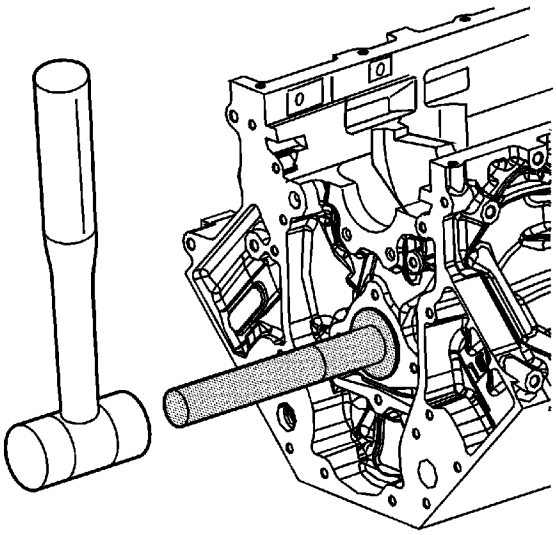


7. Insert the tool into an inner camshaft bearing and tighten until snug.

   Operate the tool from the front or rear of the engine block.

   On some engine blocks, the nut on the expander assembly is inaccessible, except from either end. In this case, you must use a socket and extension to enlarge and reduce the expander assembly.

8. Slide the nylon cone (2) into the front or rear camshaft bearing. This will properly align the tool.
9. Drive the bearing out of or into the engine block.
10. Repeat the procedure for the additional inner bearings.



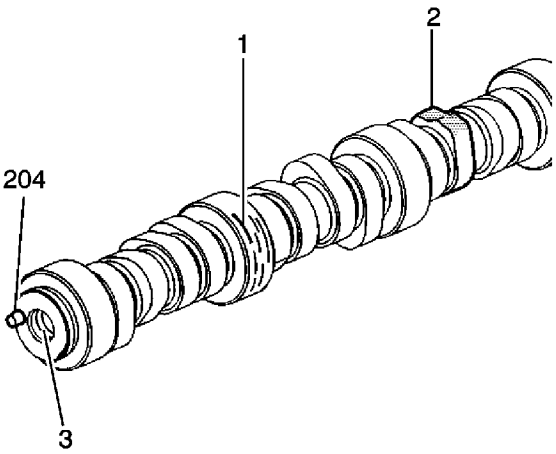
11. For the 2 end bearings, front and rear, remove the nylon cone and driver bar extension.
12. Drive the bearings out of or into the engine block.

Camshaft and Bearings Cleaning and Inspection

Special Tools

- *J 7872* Magnetic Base Dial Indicator Set
- *J 8520* Camshaft Lobe Lift Indicator

For equivalent regional tools, refer to Special Tools.



1. Clean the components in solvent.

   Warning: Refer to Safety Glasses Warning in the Preface section.

2. Dry the components with compressed air.
3. Inspect the camshaft bearing journals (1) for scoring or excessive wear.
4. Inspect the camshaft valve lifter lobes (2) for scoring or excessive wear.
5. Inspect the threaded bolt holes (3) in the front of the camshaft for damaged threads or debris.
6. Inspect the camshaft sprocket pin (204) for damage.
7. Inspect the camshaft retainer plate for wear or a damaged sealing gasket.

   If the camshaft retainer plate sealing gasket is not cut or damaged, it may be used again.

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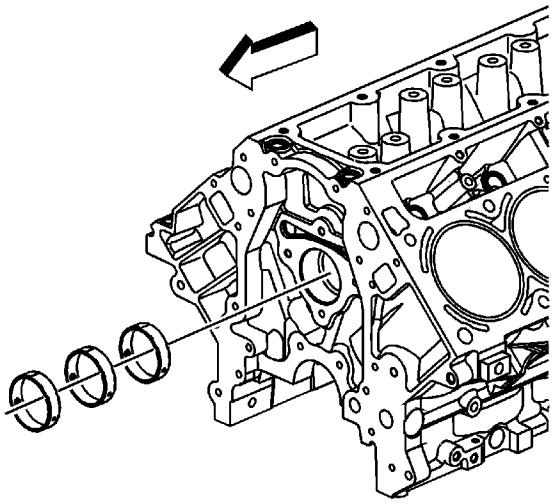
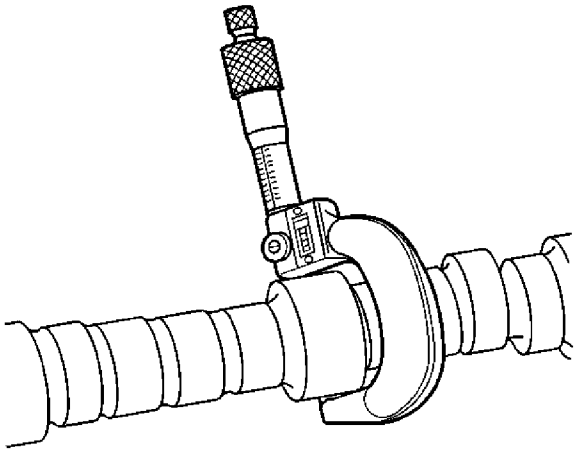


8. Inspect the camshaft bearings for the following:
   - Excessive wear or scoring. The presence of the copper color bearing material should be considered normal and not a guideline for bearing replacement. Measure the bearing inside diameter (ID) as required for an over-sized condition. Refer to Engine Mechanical Specifications.
   - Proper fit in the engine block. Camshaft bearings have an interference fit to the engine block and should not be loose in the engine block bearing bores.
   - Oil lubrication hole plugged by debris.

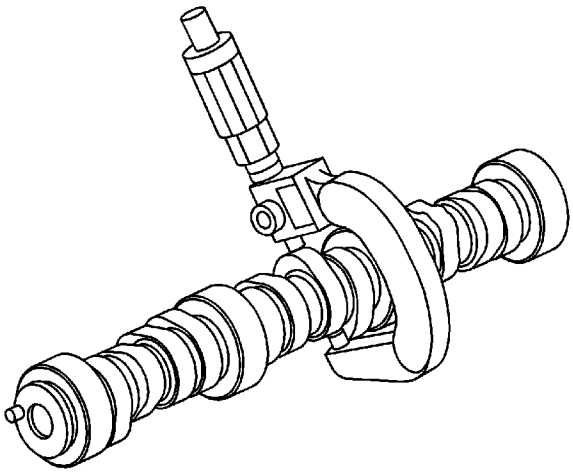
   Bearings with excessive wear or scoring must be replaced.



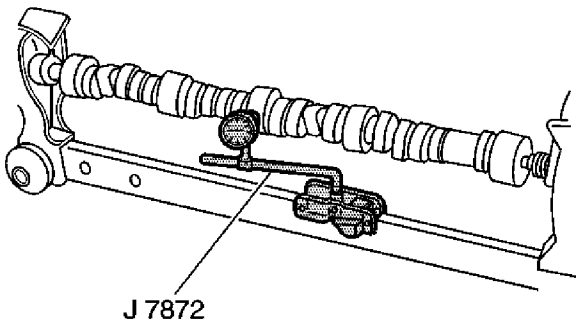
9. Using a micrometer, measure the camshaft journals for wear and out-of-round.
   - If the camshaft bearing journals are greater than **0.025 mm (0.001 in)** out-of-round,

replace the camshaft.

- If the camshaft bearing journal diameter is less than **54.99 mm (2.164 in)** , replace the camshaft.

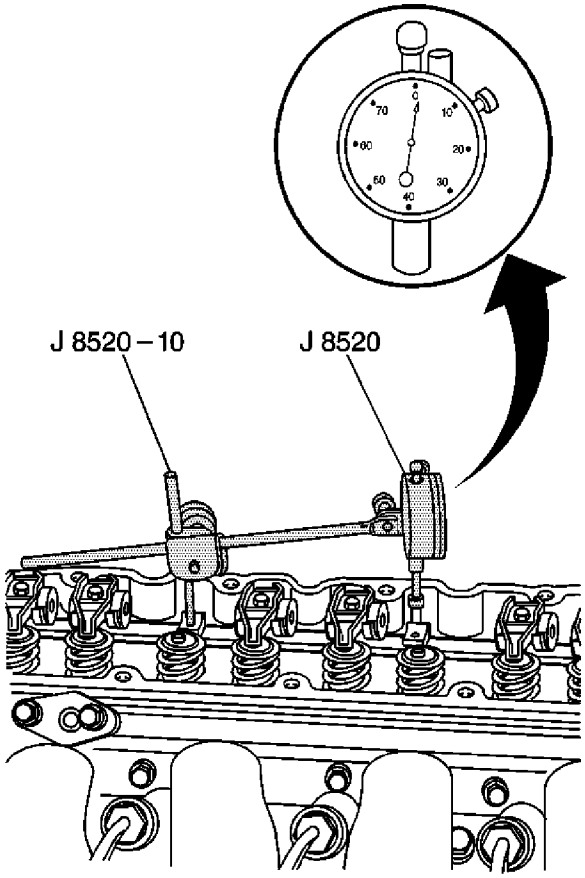


10. Using a micrometer, measure the camshaft lobes for wear. Refer to Engine Mechanical Specifications.



11. Measure the camshaft runout.
    11.1. Mount the camshaft in wooden V-blocks or between centers on a fixture.
    11.2. Using the *J 7872* dial indicator set , measure the runout of the intermediate camshaft bearing journals.
    11.3. If camshaft runout exceeds **0.05 mm (0.002 in)** , the camshaft is bent and should be replaced.

Measuring Camshaft Lobe Lift



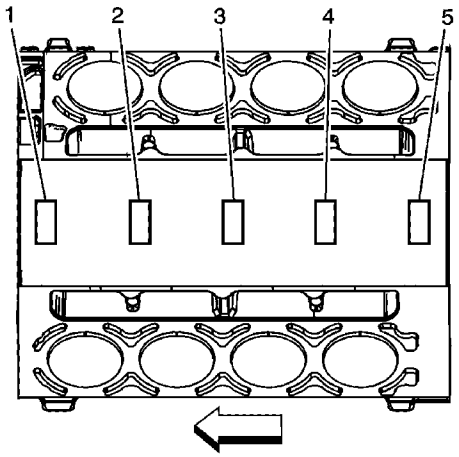
Note: Measuring camshaft lobe lift is a procedure used to determine if the camshaft lobes have worn. This test is to be performed prior to engine disassembly and with the camshaft and valve train components installed in the engine.

1. Using the *J 8520* camshaft lobe lift indicator , measure camshaft lobe lift.
2. Remove the valve rocker arms and bolts.
3. Install the dial indicator mounting stud into the valve rocker arm bolt hole.
4. Assemble the components of the *J 8520* camshaft lobe lift indicator and position onto the stud.
5. Position the shaft of the dial indicator onto the end of the pushrod.
6. Rotate the face of the dial indicator to zero.
7. Slowly rotate the crankshaft clockwise, until the dial indicator obtains its highest and lowest readings.
8. Compare the total to specifications. Refer to Engine Mechanical Specifications.

Camshaft Bearing Installation

Tools Required

J 33049 Camshaft Bearing Service Set



Important: The engine block camshaft bearing bores are machined for 3 different outside diameter (OD) size bearings. Position 1 and 5 are the largest diameter bores. Position 3 is the smallest diameter bore. Position 2 and 4 are the intermediate size bores. The inside diameter (ID) for all camshaft bearings is the same size.

1. Measure the engine block camshaft bearing bores (1-5) in order to identify the correct OD size bearing for each position. Refer to Engine Mechanical Specifications.

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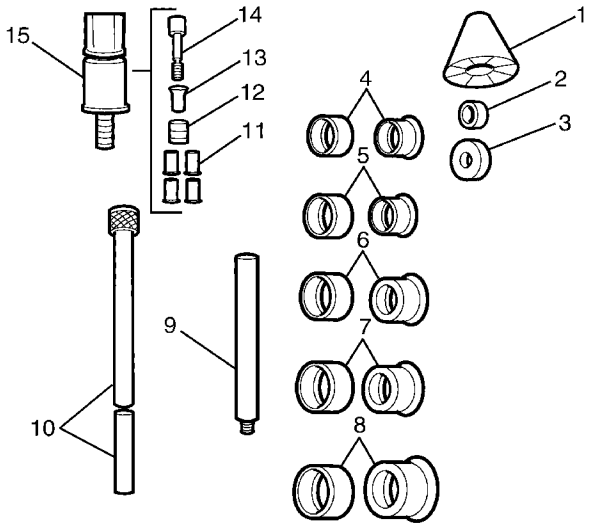
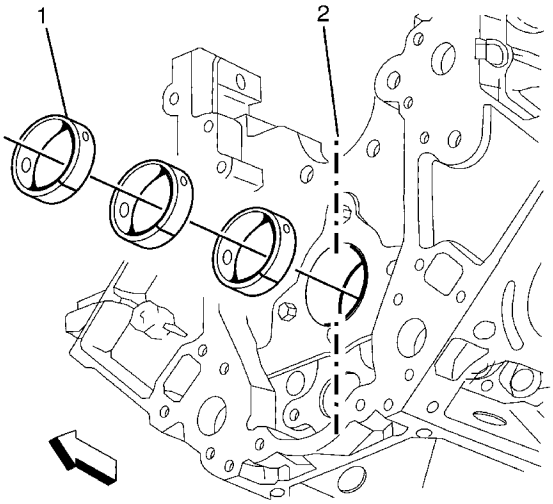


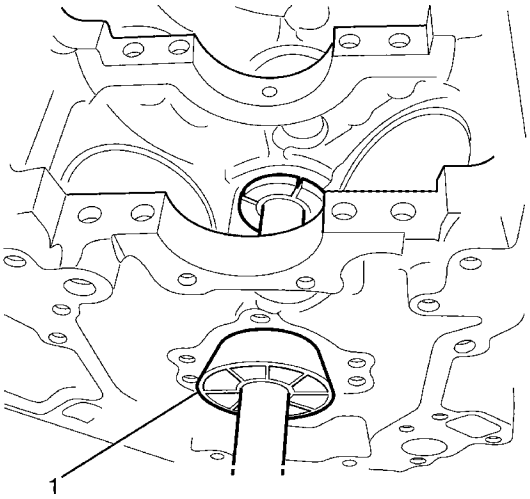
2. Select the expanding driver (4 - 8) and washer (2 or 3) from the J 33049 .
3. Assemble the tool.



Important:

- The joint in the new camshaft bearing (1) must be aligned with the top of the cylinder block centreline (2). To assist with alignment of the bearing, use a felt tip pen to mark the back of the bearing 180° from the join, as this will be visible when installing the bearing.
- Make sure the bearing is installed correctly allowing maximum exposure to the oil feed hole.

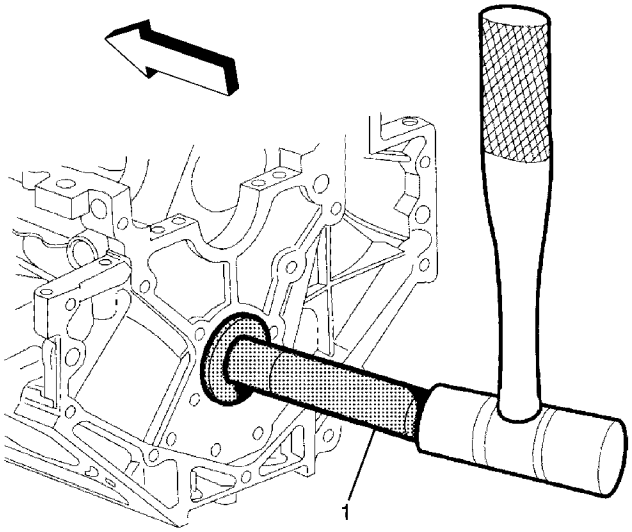
4. Align the new camshaft bearing (1) with the top of the cylinder block centreline (2).



5. Insert the tool through the front of the engine block and into the bearing.
6. Tighten the expander assembly nut until firm.
7. Push the guide cone into the front camshaft bearing in order to align the tool.

Important: After installing the bearings, use a thin piece of wire to ensure the oil feed passage has not been obstructed.

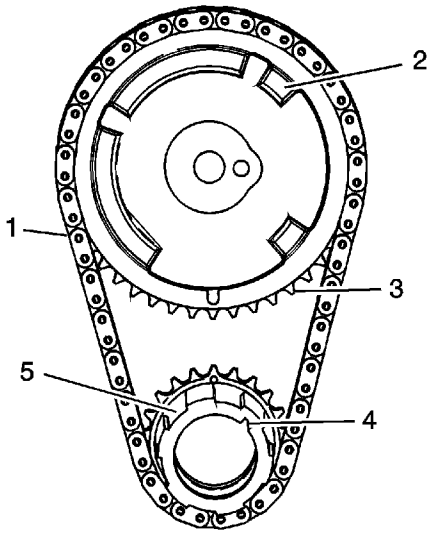
8. Drive the bearing into the block bore.



Important: After installing the bearings, use a thin piece of wire to ensure the oil feed passage has not been obstructed.

9. Install the front and rear bearings to the block.

Camshaft Timing Chain and Sprocket Cleaning and Inspection



1. Clean the components with cleaning solvent.

   Warning: Refer to Safety Glasses and Compressed Air Warning in the Preface section.

2. Dry the components with compressed air.
3. Inspect the timing chain (1) for binding or wear.
4. Inspect the camshaft position (CMP) sensor raised areas (2) for nicks or damage.
5. Inspect for worn, damaged, or chipped teeth (3).
6. Inspect for a damaged keyway (4).
7. Inspect for worn oil pump drive splines (5).

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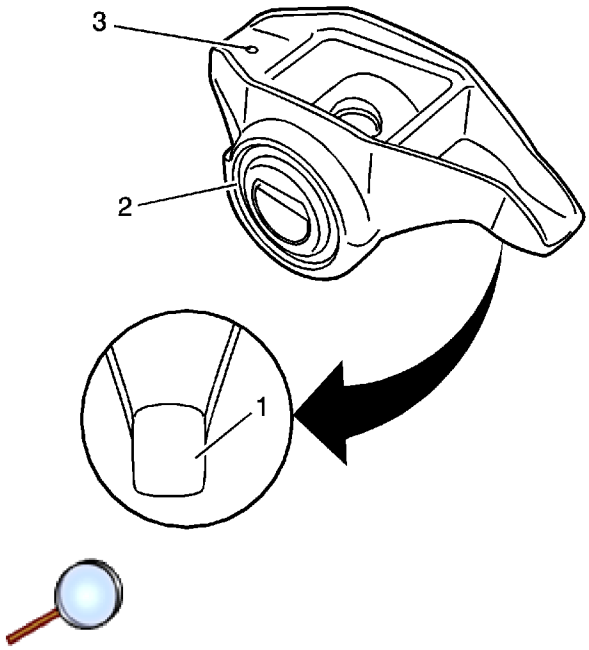
Valve Rocker Arm and Push Rod Cleaning and Inspection



Note: Parts that are to be used again must be marked, sorted or organized for assembly.

1. Mark, sort, or organize the components for assembly. Refer to Separating Parts.
2. Clean the components with cleaning solvent.

Warning: Refer to Safety Glasses and Compressed Air Warning in the Preface section.

3. Dry the components with compressed air.
4. Inspect the valve rocker arms bearings (2) for binding or roughness.
5. Inspect the valve rocker arm pushrod sockets (3) and valve stem mating surfaces (1). These surfaces should be smooth with no scoring or exceptional wear.
6. Inspect the pushrods for worn or scored ends. These surfaces should be smooth with no scoring or exceptional wear.
7. Inspect the pushrods for bends. Roll the pushrod on a flat surface to determine if the pushrod is bent.
8. Inspect the pushrod oil passages for restrictions.
9. Inspect the rocker arm pivot supports for cracks, wear, or other damage.

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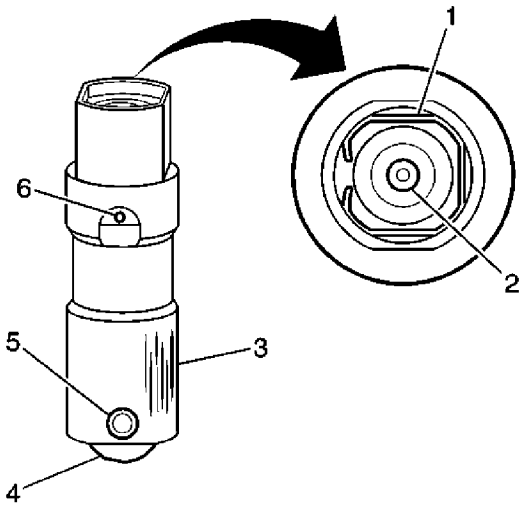
Valve Lifter and Guide Cleaning and Inspection

Non Active Fuel Management Valve Lifters



Note: Components that are to be used again must be marked, sorted or organized for assembly.

1. Clean the components in cleaning solvent.

   Warning: Refer to Safety Glasses and Compressed Air Warning in the Preface section.

2. Dry the components with compressed air.
3. Inspect the valve lifters for the following conditions:
   - Bent or broken clip (1)
   - Worn pushrod socket (2)
   - Scuffed or worn sides (3)

     If the valve lifter shows wear, inspect the engine block lifter bores for wear or damage.
   - Flat spots on the roller (4)
   - Loose or damaged pin (5)
   - Plugged oil hole (6)
   - Worn or damaged roller bearing

     The roller should rotate freely with no binding or roughness.

Active Fuel Management Valve Lifters

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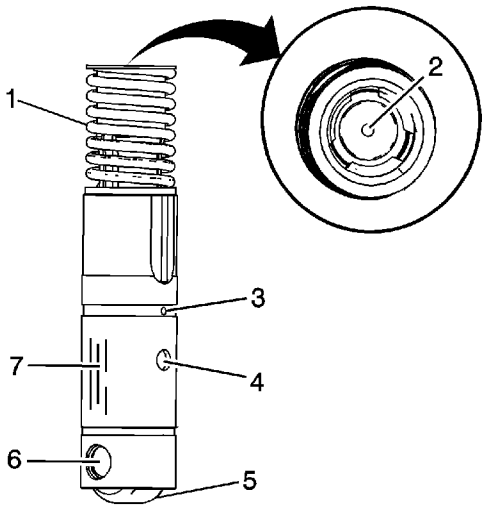


Note: Components that are to be used again must be marked, sorted or organized for assembly.

1. Clean the components in cleaning solvent.

   Warning: Refer to Safety Glasses and Compressed Air Warning in the Preface section.

2. Dry the components with compressed air.
3. Inspect the valve lifters for the following conditions:
   - Broken or collapsed spring (1)
   - Worn pushrod socket (2)
   - Plugged lubrication hole (3)
   - Plugged lifter oil-switching hole (4)
   - Flat spots on the roller (5)
   - Worn or damaged roller bearing (6)

     The roller should rotate freely with no binding or roughness.
   - Scuffed or worn sides (7)

Valve Guides

Inspect the valve lifter guides for the following conditions:

- Cracks or damage
- Excessive wear in the lifter mounting bores

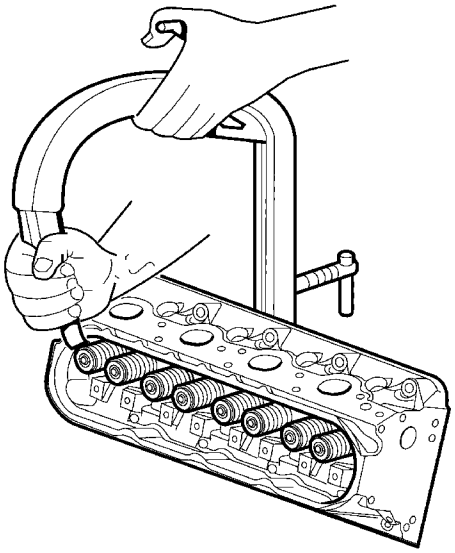
Cylinder Head Disassemble

Special Tools

J 8062 Valve Spring Compressor - Head Off

For equivalent regional tools, refer to Special Tools.

1. Remove the spark plugs from the cylinder heads. Refer to Spark Plug Replacement.



Note:

- With the components at room temperature, remove the spark plugs from the cylinder head.
- Mark, organize, or sort the cylinder head components for assembly. Return the components to their original location during assembly.

2. Use a commercially available valve spring compressor in order to compress the valve spring.

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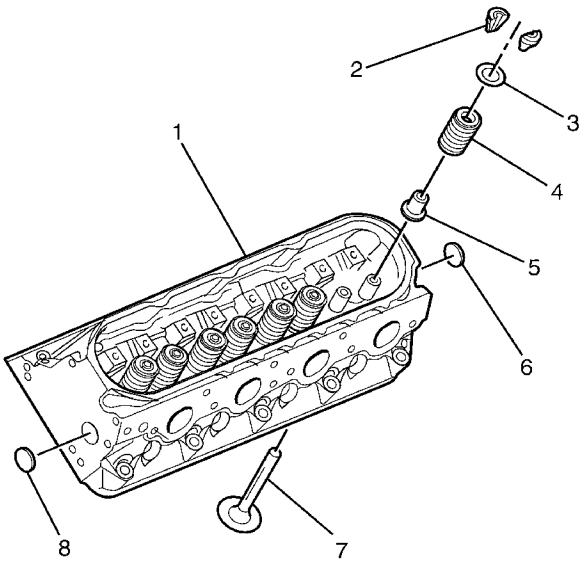
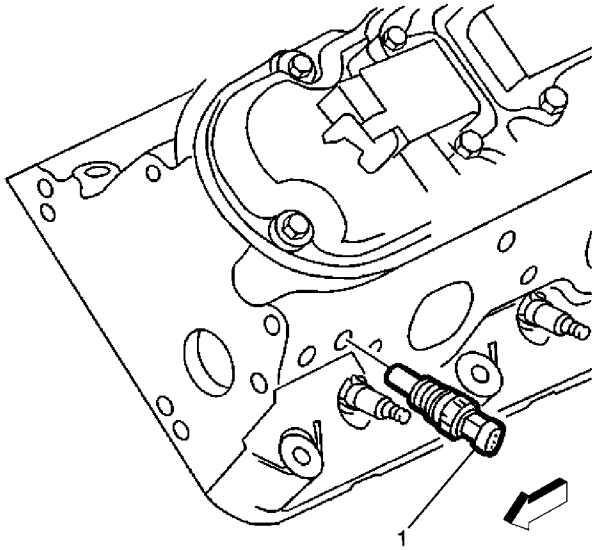
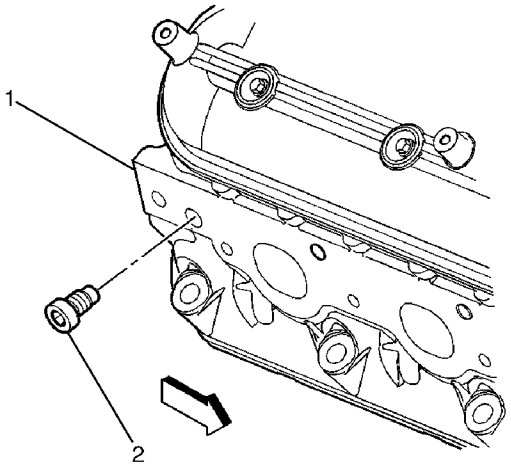


3. Remove the valve stem keys (2).
4. Release the spring compressor and remove from the cylinder head (1).
5. Remove the valve spring cap (3).
6. Remove the valve spring (4).
7. Remove the valve (7).
8. Remove the valve stem oil seal (5). Refer to Separating Parts.
9. Repeat steps 2-8 for each valve as required.
10. Remove the cylinder head core hole plugs (6), as required.

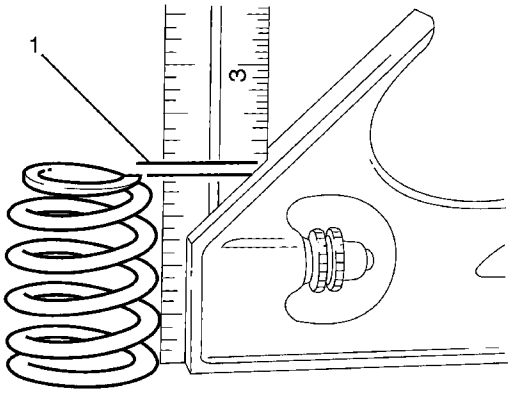


Caution: Use care when handling the coolant sensor. Damage to the coolant sensor will affect the operation of the fuel control system.

11. Remove the ECT sensor (1) from the cylinder head.

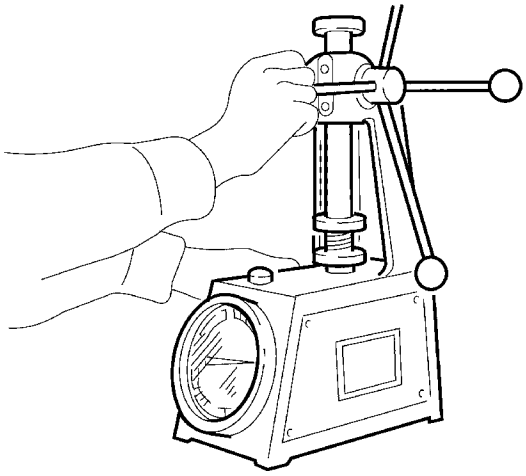


12. Remove the coolant plug (2) from the right cylinder head (1).



13. Check all valve springs for distortion. There should be no more than 1.6 mm variance (1) of the spring end while the spring is being rotated on a flat surface.

    Replace springs that exceed this specification.



14. Use a commercially available valve spring tester and measure each valve spring for free height and tension. Refer to Engine Mechanical Specifications.

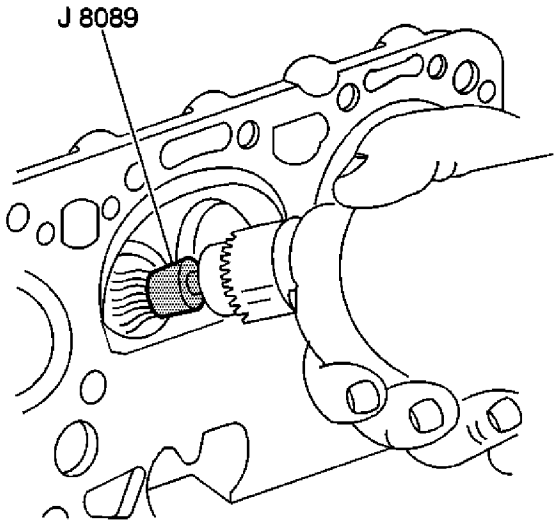
Cylinder Head Cleaning and Inspection

Special Tools

- *J 8089* Carbon Removal Brush
- *J 9666* Valve Spring Tester

For equivalent regional tools, refer to Special Tools.

Warning: Refer to Safety Glasses Warning in the Preface section.



Note:

- When cleaning a cylinder head in a thermal type oven, do not exceed 204°C (400°F).
- Be careful not to scuff the chamber.

1. Clean the following components:
   - Use the *J 8089* brush in order to remove the carbon from the combustion chambers.
   - Gasket surfaces

     Refer to Replacing Engine Gaskets.
   - Valve stems and heads on a buffing wheel
   - Bolt hole threads

     Remove all dirt, debris, or threadlocking material from the bolt holes.
2. Inspect the cylinder head for the following conditions:
   2.1. Cracks in the exhaust ports and combustion chambers

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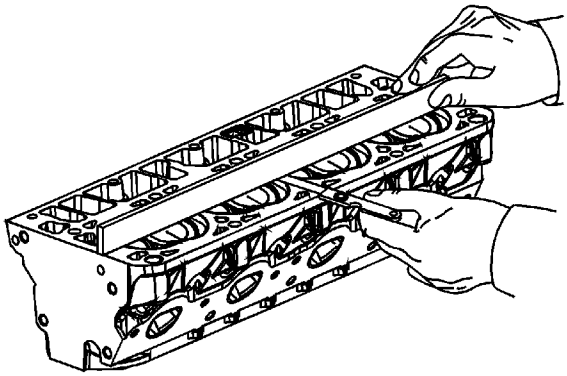
2.2. External cracks in the water chambers
2.3. Gasket surfaces for excessive scratches or gouging

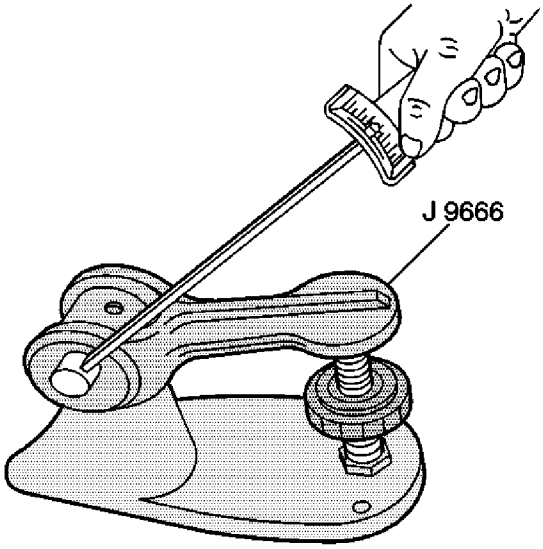
Refer to Replacing Engine Gaskets.

2.4. Bolt hole threads for debris or damaged threads

Refer to Thread Repair or Thread Repair Specifications.

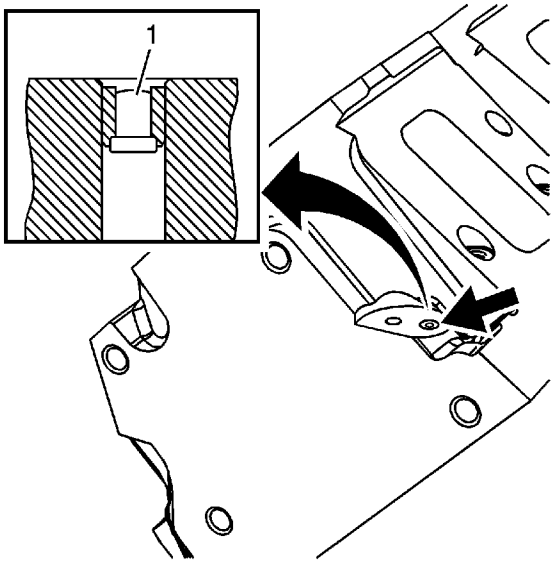


3. Inspect the cylinder head for warpage. Refer to Engine Mechanical Specifications.



4. Use the *J 9666* tester in order to measure the valve spring tension. Refer to Engine

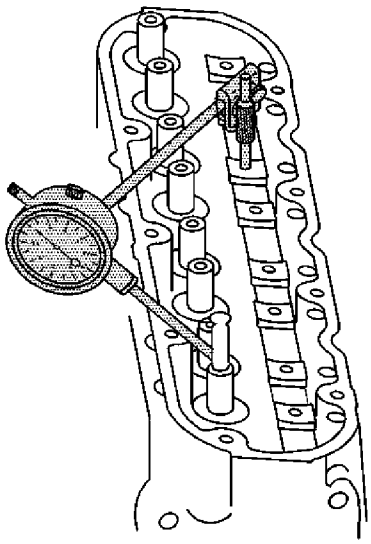
Mechanical Specifications.



5. Inspect for a leaking plug (1). Second design applications use a rivet-type plug at the top rear coolant passage of each cylinder head. If service of a leaking plug is required, it is necessary to remove the cylinder head from the engine to properly remove the plug. Refer to Cylinder Head Disassemble.

Valve Guide Reaming, and Valve and Seat Grinding

Valve Guide Reaming



Caution: Excessive valve stem-to-guide clearance may cause a noisy valve train, premature valve stem oil seal wear, component damage, and/or excessive engine oil consumption.

Caution: Insufficient valve stem-to-guide clearance will result in noisy or sticking valves. Valves that are too tight may disturb engine smoothness or lead to component damage.

1. Using a dial indicator, measure the valve stem-to-guide clearance. Position the tip of the dial indicator at the top of the valve guide.

   Valve stem-to-guide clearance may also be obtained by using a micrometer to measure the valve stem diameter and a ball type measuring gage to measure the guide bore.

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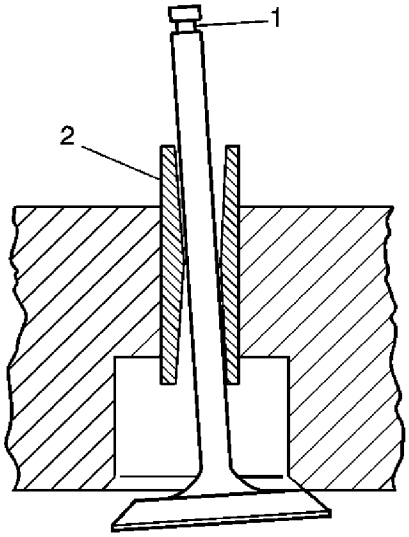
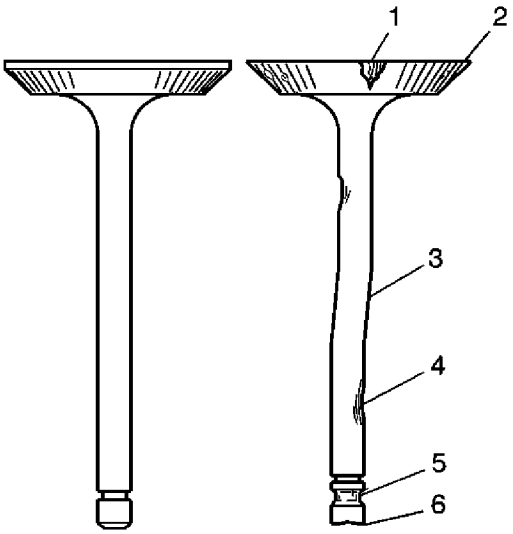


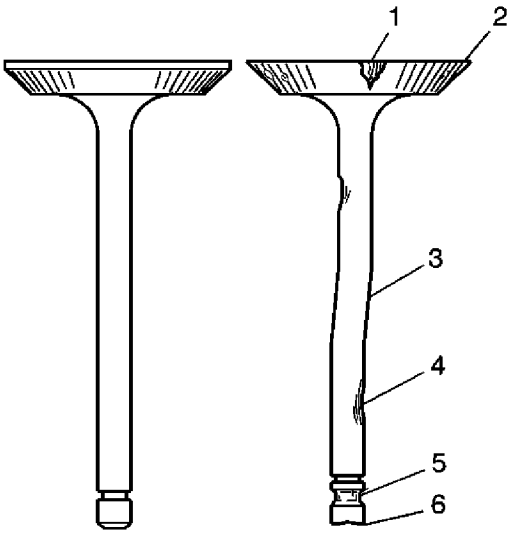
2. A valve stem (1) and guide (2), with excessive clearance, must be replaced or the cylinder head replaced. Refer to Engine Mechanical Specifications.



3. Inspect the valve stems for excessive scoring, wear, or warpage.
   - A valve stem that has excessive scoring (3 or 4) or wear (4 or 6) must be replaced.
   - If a valve guide is worn or has excessive stem-to-guide clearance, the cylinder head should be replaced.
4. Measure the valve stem diameter. A valve stem with a diameter less than 7.95 mm (0.313 in) must be replaced.

   If the valve stem diameter is within specifications, and the stem-to-guide clearance is excessive, the cylinder head must be replaced.

Valve and Seat Grinding

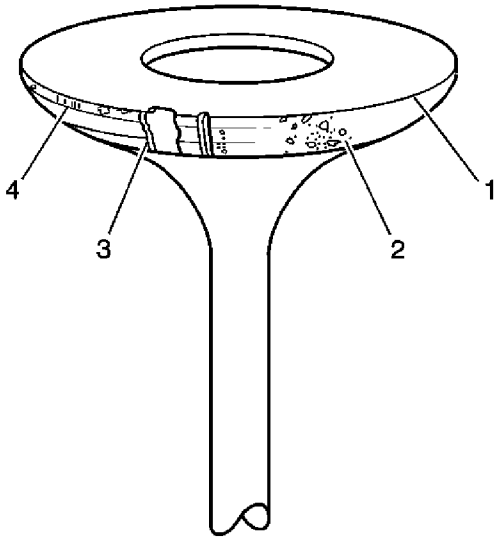


Note:

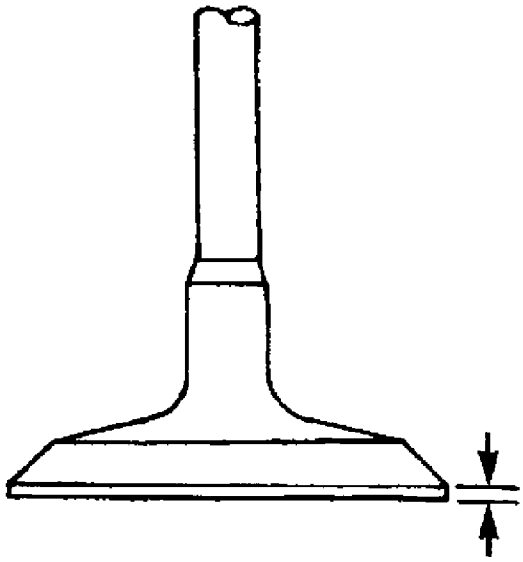
- Reconditioning the valve seats is very important. The seating of the valves must be perfect for the engine to deliver optimum power and performance. Several different types of equipment are available for grinding valve seats.
- Another important factor is the cooling of the valve head. Good contact between the valve and the seat will ensure that heat will be properly dissipated.
- The recommendations of the equipment manufacturer should be followed carefully to obtain the proper results. Regardless of the type of equipment used, it is essential that valve guide bores be free of carbon or dirt to ensure proper centering of the tool pilot in the guide.
- Valves that are pitted must be refaced to the proper angle. Valve stems that show excessive wear, or valves that are warped excessively must be replaced. When a valve head that is warped excessively is refaced, a knife edge may be ground on part or all of the valve head due to the amount of metal that must be removed. Knife edges lead to breakage, burning or pre-ignition due to heat localizing on this knife edge. If the edge of the valve head is less than 1.25 mm (0.05 in) after grinding, replace the valve.
- Several different types of equipment are available for refacing valves. The recommendation of the equipment manufacturer should be carefully followed to obtain the proper results.
- DO NOT reface intake valves. Intake valves with excessive wear or damage MUST be replaced.

1. Inspect the valve for the following conditions:
   - Burnt or eroded areas (1)
   - A worn margin (2)
   - A bent stem (3)

- A worn or scored stem (4)
- A worn key groove (5)
- A worn stem tip (6)



2. Inspect the valve face for the following conditions:
   - Worn or no margin (1 or 4)
   - Pitted surfaces (2)
   - Burnt or eroded areas (3)



3. Inspect the valve margin.

The exhaust valve may be refaced if the margin is greater than 1.25 mm (0.05 in) thick before grinding.

4. Reface pitted exhaust valves on a suitable valve refacing machine.
5. Replace the valve if the margin is less than 1.25 mm (0.05 in) thick after grinding.
6. If the valve face has been ground, it may be necessary to shim the valve spring in order to obtain the proper spring installed height. Refer to Cylinder Head Disassemble.
7. Inspect for a loose valve seat in the cylinder head. The valve seat has an interference fit to the cylinder head.
8. Clean the valve guide bores with a suitable tool. Remove all carbon or dirt from the bores.

   The valve guide must be clean for the seat grinding tool to obtain proper results.

9. Grind the valve seat.

   The recommendations of the equipment manufacturer should be followed carefully to obtain the proper results. Regardless of the type of equipment used, it is essential that valve guide bores be free from carbon or dirt to ensure proper centering of the tool pilot in the guide.

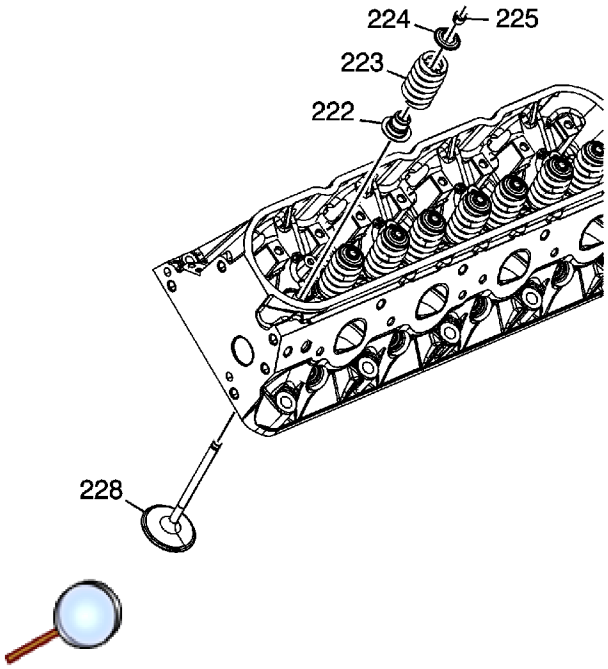
10. Inspect the valve seats.
    - The valve seats should be concentric to within 0.05 mm (0.0021 in) total indicator reading.
    - If the valve seat has been ground, it may be necessary to shim the valve spring in order to attain the proper spring installed height. Refer to Cylinder Head Disassemble.

Cylinder Head Assemble

Special Tools

J 8062 Valve Spring Compressor - Head Off

For equivalent regional tools, refer to Special Tools.



1. Clean the cylinder head valve spring seat area.

   Note: When using the valves and related components again, install the parts to their original location.

2. Install the valves (228) into the proper port. Refer to Separating Parts.
3. Install the valve stem oil seal (222).
4. Install the valve spring (223).
5. Install the valve spring cap (224).

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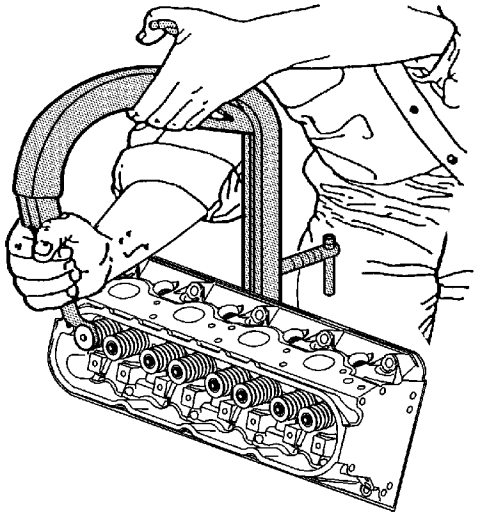
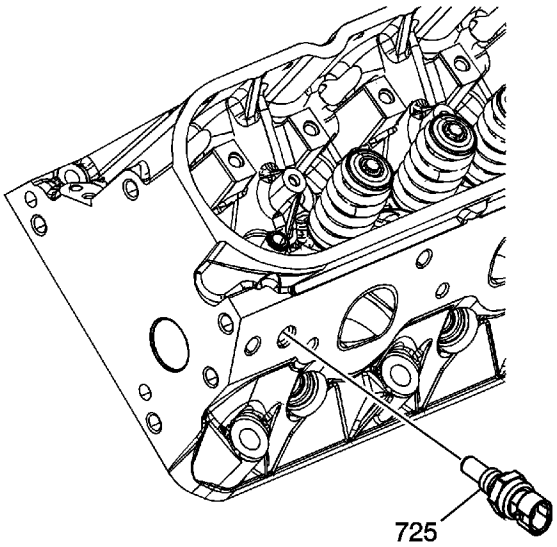


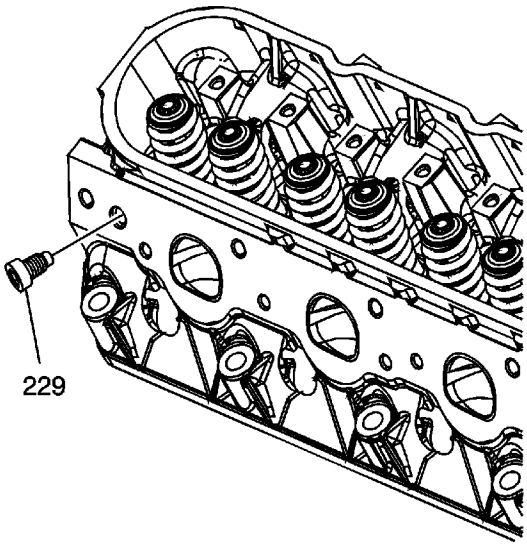
6. Using the *J 8062* valve spring compressor , compress the valve spring.
7. Install the valve stem keys.
   7.1. Use grease in order to hold the keys in place and remove the *J 8062* valve spring compressor .
   7.2. Ensure the keys seat properly in the groove of the valve stem.
   7.3. Tap the end of the valve stem with a plastic face hammer to seat the keys, if necessary.
8. Install the remaining valves, springs, and other components.



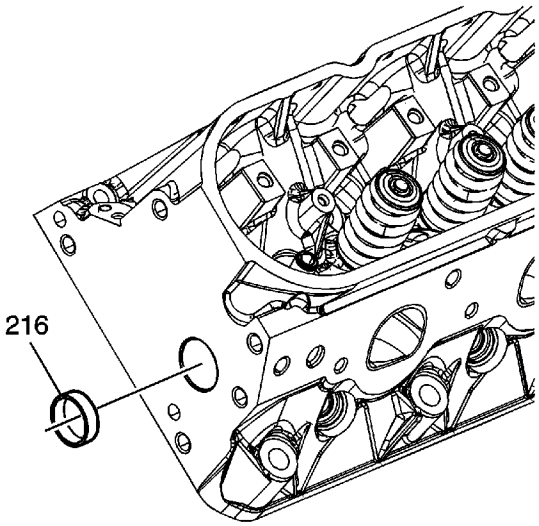
9. Install sealant GM P/N 12346004 (Canadian P/N 10953480), or equivalent, to the threads of the coolant temperature sensor (725).

Caution: Refer to Fastener Caution in the Preface section.

10. Install the coolant temperature sensor into the left cylinder head and tighten to **20 N·m (15 lb ft)**.

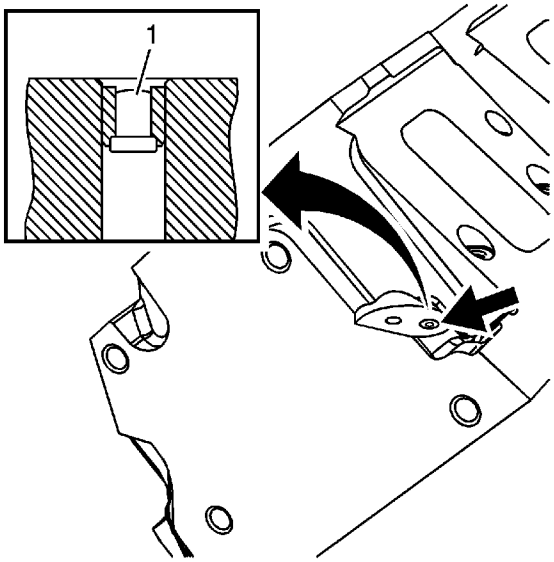


11. Install sealant GM P/N 12346004 (Canadian P/N 10953480), or equivalent, to the threads of the cylinder head plug (229).
12. Install the cylinder head plug to the right cylinder head and tighten to **20 N·m (15 lb ft)**.

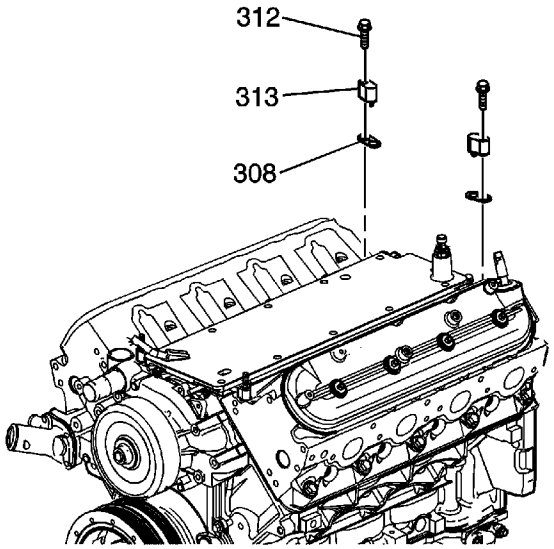


13. Apply threadlock GM P/N 12345382 (Canadian P/N 10953489), or equivalent, to the sides of the cylinder head plugs (216).
14. Install the cylinder head plugs into the cylinder head.

    A properly installed plug should be installed **2.5 mm (0.1 in)** below the end face of the head.

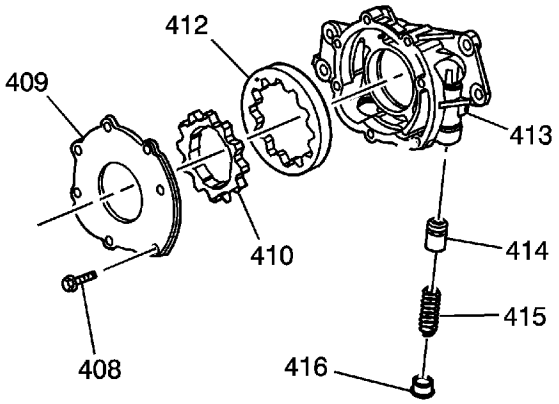


15. Second design applications use a rivet-type plug (1) at the top rear coolant passage of each cylinder head. If service of a leaking plug is required, it is necessary to remove the cylinder head from the engine to properly remove the plug. Refer to Cylinder Head Disassemble.



16. If plug removal is required, install a first design coolant air bleed cover and bolt to complete the repair.

Oil Pump Disassemble



Important: The internal parts of the oil pump assembly are not serviced separately, excluding the spring. If the oil pump components are worn or damaged, replace the oil pump as an assembly.

1. Remove the oil pump cover bolts (408).
2. Remove the oil pump cover (409).

Important: Mark or identify the gears for assembly. Refer to Separating Parts.

3. Remove the drive gear (410).
4. Remove the driven gear (412).
5. Remove the pressure relief valve plug (416).
6. Remove the pressure relief valve spring (415).
7. Remove the pressure relief valve (414).
8. Inspect the oil pump components. Refer to Oil Pump Cleaning and Inspection.

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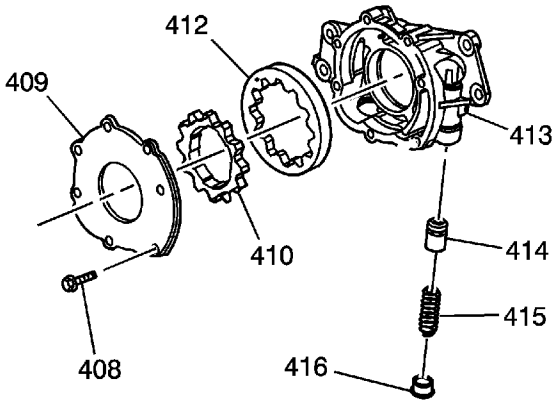
Oil Pump Cleaning and Inspection



Note:

- The internal parts of the oil pump assembly are not serviced separately, excluding the spring. If the oil pump components are worn or damaged, replace the oil pump as an assembly.
- The oil pump pipe and screen are to be serviced as an assembly. Do not attempt to repair the wire mesh portion of the pump and screen assembly.

1. Clean the parts in solvent.

   Warning: Refer to Safety Glasses and Compressed Air Warning in the Preface section.

2. Dry the parts with compressed air.
3. Inspect the oil pump housing (413) and the cover (409) for cracks, excessive wear, scoring, or casting imperfections.
4. Inspect the oil pump housing-to-engine block oil gallery surface for scratches or gouging.
5. Inspect the oil pump housing for damaged bolt hole threads.
6. Inspect the relief valve plug (416) and plug bore for damaged threads.
7. Inspect the oil pump internal oil passages for restrictions.
8. Inspect the drive gear (410) and driven gear (412) for chipping, galling, or wear.

   Minor burrs or imperfections on the gears may be removed with a fine oil stone.

9. Inspect the drive gear splines for excessive wear.
10. Inspect the pressure relief valve (414) and bore for scoring or wear.

    The valve must move freely in the bore, with no restrictions.

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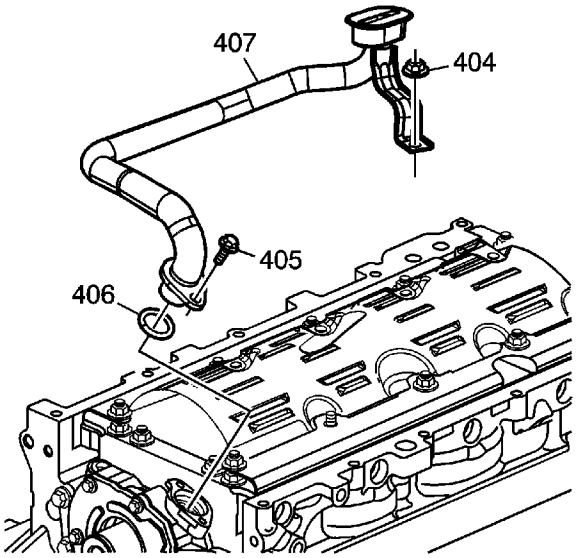
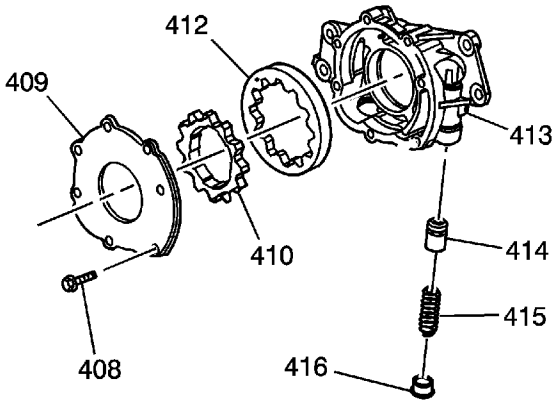


11. Inspect the oil pump screen (407) for debris or restrictions.
12. Inspect the oil pump screen for broken or loose wire mesh.

Oil Pump Assemble



Note: Prior to assembling the oil pump, coat all wear or internal surfaces with clean engine oil.

1. Install the driven gear (412) into the pump housing (413).

   Install the driven gear with the orientation mark facing the pump cover.

2. Install the drive gear (410) into the pump housing.
3. Install the oil pump cover (409).

   Caution: Refer to Fastener Caution in the Preface section.

4. Install the oil pump cover bolts (408) and tighten to **12 N·m (106 lb in)**.
5. Install the relief valve (414).
6. Install the relief valve spring (415).
7. Install the relief valve plug (416) and tighten to **12 N·m (106 lb in)**.
8. Inspect the oil pump for smooth operation by rotating the drive gear.

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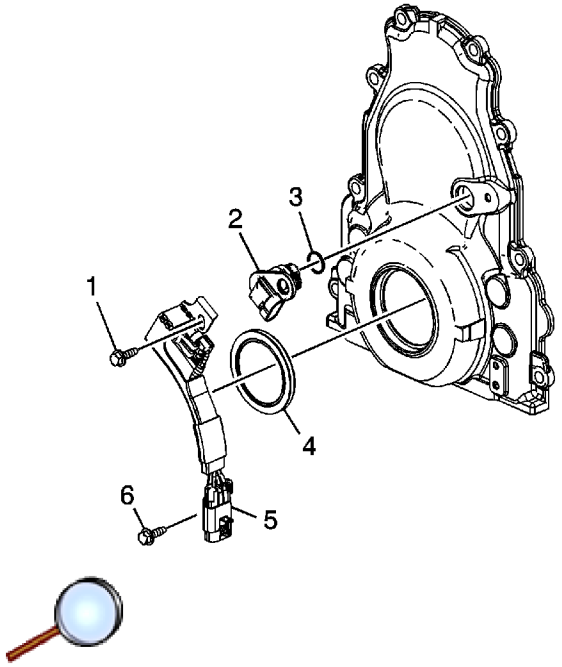
Engine Front Cover Cleaning and Inspection



Note:

- Do not use the crankshaft oil seal again. Install a NEW crankshaft oil seal during assembly.
- Do not use the front cover-to-engine block gasket again. Install a NEW gasket during assembly.

1. Remove the crankshaft oil seal (4) from the front cover.
2. Clean the cover in solvent. Remove the sealant from the cover oil pan surface. Refer to Replacing Engine Gaskets.

Warning: Refer to Safety Glasses and Compressed Air Warning in the Preface section.

3. Dry the cover with compressed air.
4. Inspect the gasket sealing surfaces for excessive scratches or gouging.
5. Inspect the threaded bolt holes for damaged threads or debris.
6. Inspect the crankshaft oil seal and camshaft position (CMP) sensor mounting bores for damage.

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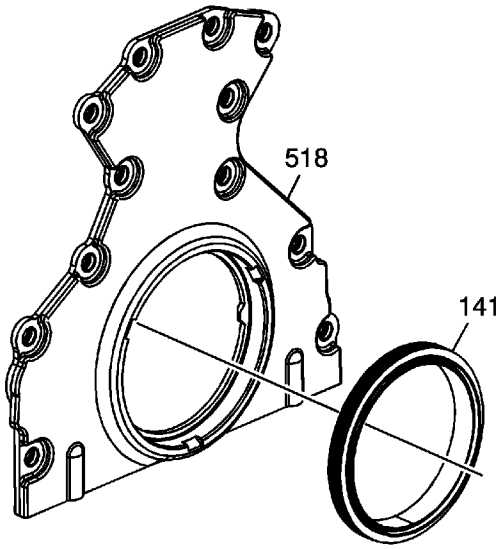
Crankshaft Rear Oil Seal Housing Cleaning and Inspection



Note:

- Do not use the crankshaft rear oil seal again. Install a NEW crankshaft oil seal during assembly.
- Do not use the rear housing-to-engine block gasket again. Install a NEW gasket during assembly.

1. Remove the crankshaft oil seal (141) from the rear housing.
2. Clean the housing in solvent. Remove the sealant from the housing oil pan surface. Refer to Replacing Engine Gaskets.

Warning: Refer to Safety Glasses and Compressed Air Warning in the Preface section.

3. Dry the housing with compressed air.
4. Inspect the gasket sealing surfaces for excessive scratches or gouging.
5. Inspect the housing-to-oil pan threaded bolt holes for damaged threads or debris.
6. Inspect the crankshaft oil seal mounting bore for damage.

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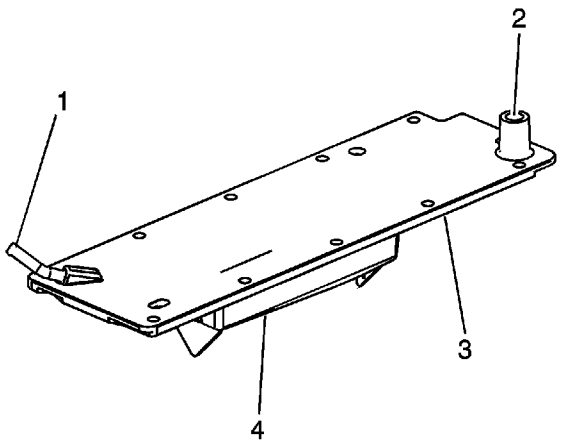
Engine Block Valley Cover Cleaning and Inspection



1. Clean the valley cover in solvent.

   Warning: Refer to Safety Glasses and Compressed Air Warning in the Preface section.

2. Dry with compressed air.
3. Inspect for restrictions within the positive crankcase ventilation (PCV) passages (1, 4).
4. Inspect for damaged threads (2) and damaged sealing surfaces (3).

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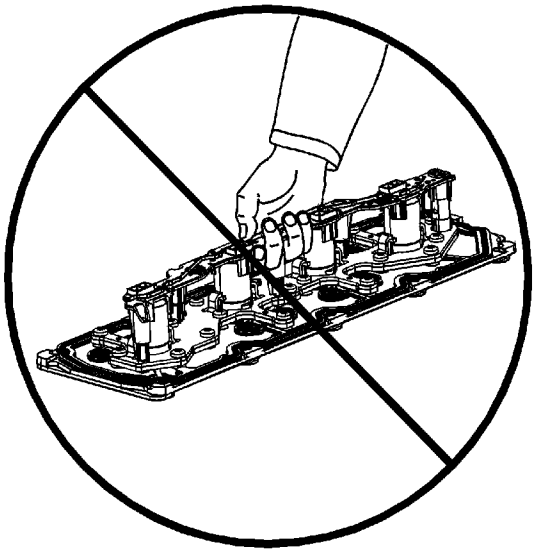
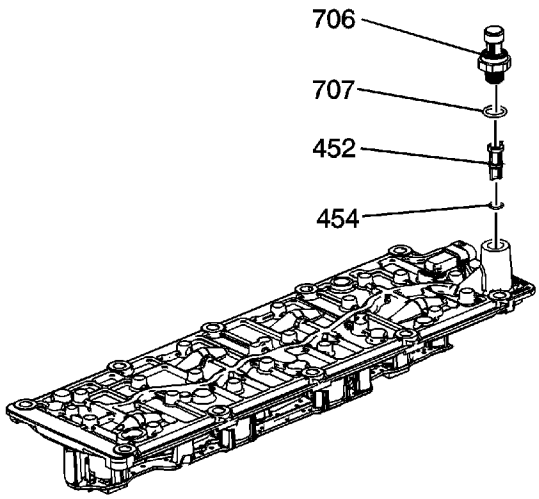
Valve Lifter Oil Manifold Cleaning and Inspection



Note:

- Do not allow dirt or debris to enter the oil passages of the manifold. Plug, as required.
- Do not disassemble the electrical components from the manifold.
- Do not submerge the electrical components in cleaning solvent.
- Do not use the manifold exterior gasket again. Remove the exterior gasket and install a NEW service gasket during assembly.

1. Do not lift the manifold assembly by the electrical lead frame.



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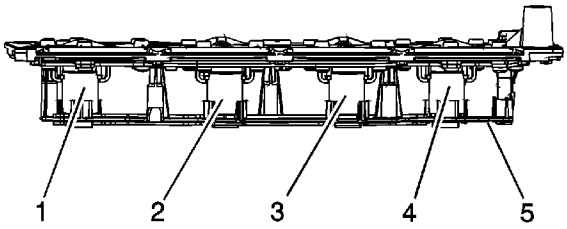
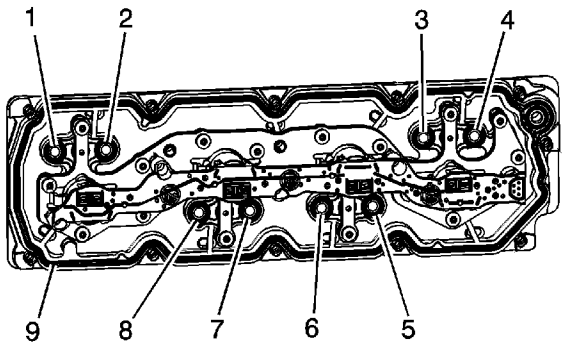
2. Remove the oil pressure sensor (706) and washer (707).
3. Remove the oil screen (452) with O-ring (454).

Warning: Refer to Safety Glasses and Compressed Air Warning in the Preface section.

4. Clean the manifold with compressed air.



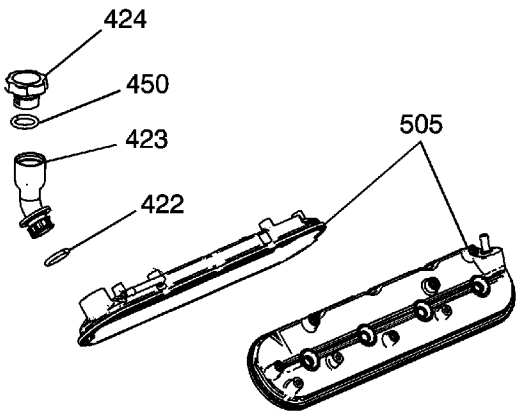
5. Inspect for loose electrical solenoids (1-4) or loose or missing bolts.
6. Inspect for damage to the electrical lead frame (5).
7. Inspect for a damaged electrical connector, for bent or corroded pins.



8. Inspect for damaged interior sealing gaskets (1-8). If the interior sealing gaskets are damaged, the manifold must be replaced as an assembly.

9. Inspect for a damaged exterior sealing gasket (9) or scored gasket surfaces.
10. Inspect for debris or restrictions within the oil passages of the manifold. Refer to Cylinder Deactivation (Active Fuel Management) Valve Lifter Oil Manifold Diagnosis and Testing.

Valve Rocker Arm Cover Cleaning and Inspection



Important:

- Do not use the valve rocker arm cover gasket again. Install a NEW gasket during assembly.
- Remove the ignition coils before cleaning the cover in solvent. Do not submerge the ignition coils in solvent.
- Do not remove the oil fill tube from the covers unless service is required. If the tube is removed from the cover, install a NEW tube (423) and seal (422) during assembly.

1. Inspect the oil fill tube (423) for a loose fit or damage.
2. Inspect the covers (505) for the following conditions:
   - Scoring or damage to the gasket surfaces
   - Ventilation system passages for restrictions
   - Threaded bolt holes for damage or debris

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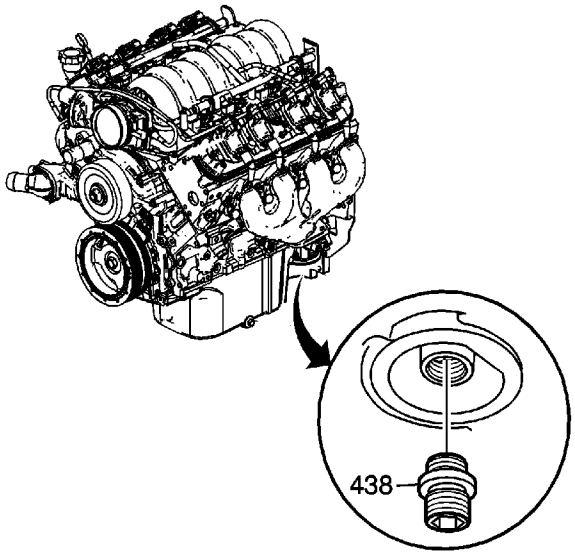
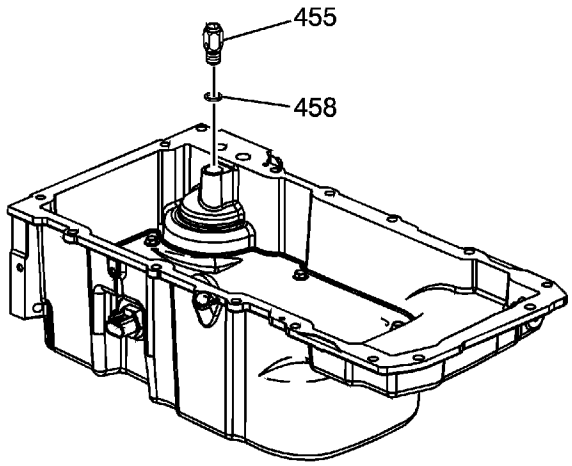
Oil Pan Cleaning and Inspection



1. Remove the oil filter fitting (438) as required. Refer to Oil Filter, Adapter, and Pan Cover Removal.



2. Remove the active fuel management oil pressure relief valve (455) and washer (458).

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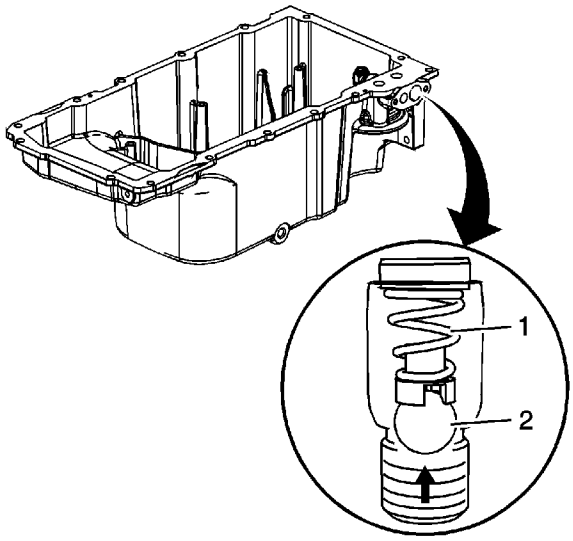
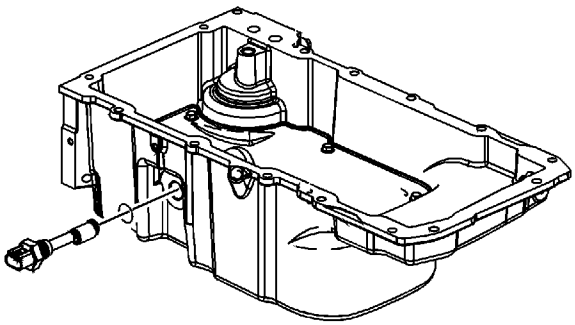
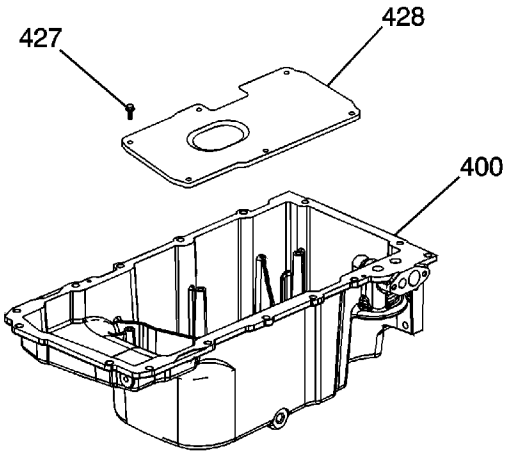


3. Inspect the active fuel management oil pressure relief valve for proper operation. Lightly depress the ball (2). The valve spring (1) should seat the ball to the proper closed position.



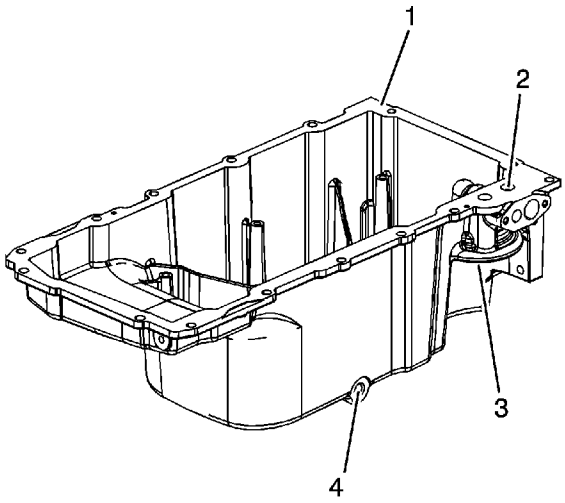
4. Remove the oil level sensor and O-ring.



5. Remove the bolts (427) and baffle (428).
6. Clean the oil pan in solvent.

Warning: Refer to Safety Glasses and Compressed Air Warning in the Preface section.

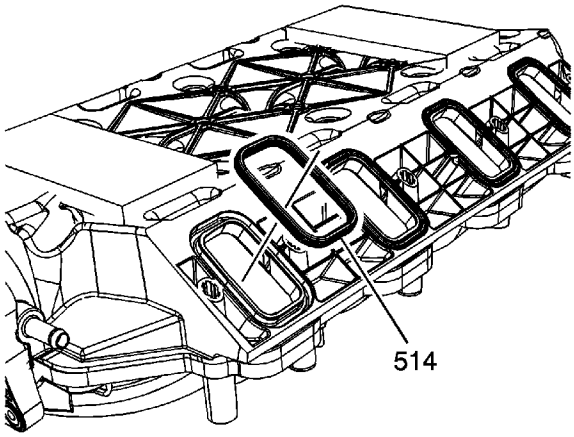
7. Dry the oil pan with compressed air.



8. Inspect the oil pan for the following conditions:
   - Damaged gasket surfaces (1)
   - Restrictions within the oil passages (2) of the pan
   - Damaged oil filter seal surface (3)
   - Threaded bolt holes (4) for damage

Intake Manifold Cleaning and Inspection

Cleaning Procedure



1. Remove and discard the intake manifold-to-cylinder head gaskets (514).
2. Remove the manifold absolute pressure (MAP) sensor. Refer to Intake Manifold Removal.
3. Remove the evaporative emission (EVAP) canister purge solenoid valve, EVAP tubes, and fuel rail with injectors. Refer to Fuel Rail and Injectors Removal.
4. Remove the throttle body and gasket. Refer to Throttle Body Removal.
5. Clean the intake manifold in solvent.

   Warning: Refer to Safety Glasses and Compressed Air Warning in the Preface section.

6. Dry the intake manifold with compressed air.

Inspection Procedure

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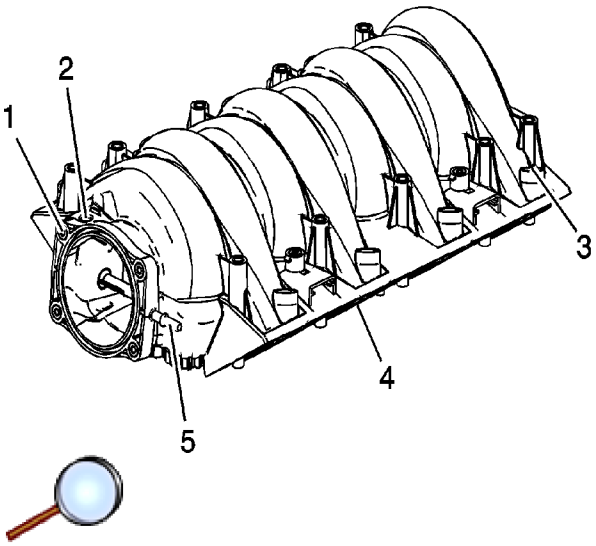


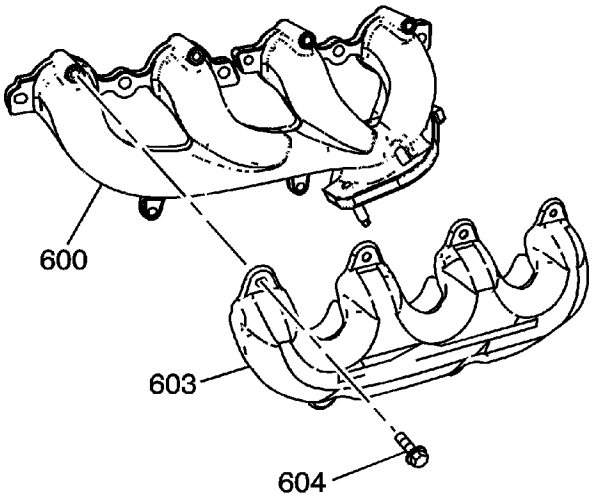
1. Inspect the manifold for the following conditions:
   - Loose threaded inserts (1)
   - Damaged MAP sensor bore (2)
   - Damaged fuel injector bore (3)
   - Damaged gasket or sealing surfaces (4)
   - Damaged or broken vacuum fittings (5)
   - Debris or restrictions within the passages of the manifold
   - Inspect the composite intake manifold assembly for cracks or other damage.
2. Inspect the intake manifold cylinder head deck for warpage.
   2.1. Locate a straight edge across the intake manifold cylinder head deck surface.

   Position the straight edge across a minimum of two runner port openings.

   2.2. Insert a feeler gage between the intake manifold and the straight edge.

   An intake manifold with warpage in excess of **3 mm (0.118 in)** over a **200 mm (7.87 in)** area is warped and should be replaced.

Exhaust Manifold Cleaning and Inspection



Note: Do not use the exhaust manifold-to-cylinder head gaskets again. Upon installation of the exhaust manifold, install a NEW gasket. An improperly installed gasket or leaking exhaust system may effect on-board diagnostics (OBD) II system performance.

1. Clean the exhaust manifold (600) and heat shield (603) in solvent.

   Warning: Refer to Safety Glasses and Compressed Air Warning in the Preface section.

2. Dry the exhaust manifold with compressed air.
3. Inspect the exhaust manifold-to-cylinder head gasket surface for excessive scratches or gouging.
4. Inspect for a loose, damaged, or cracked heat shield (603), or missing bolts (604).
5. Inspect the exhaust pipe studs for damaged threads.

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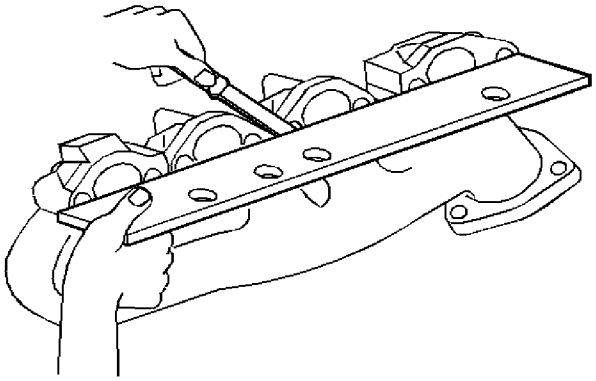
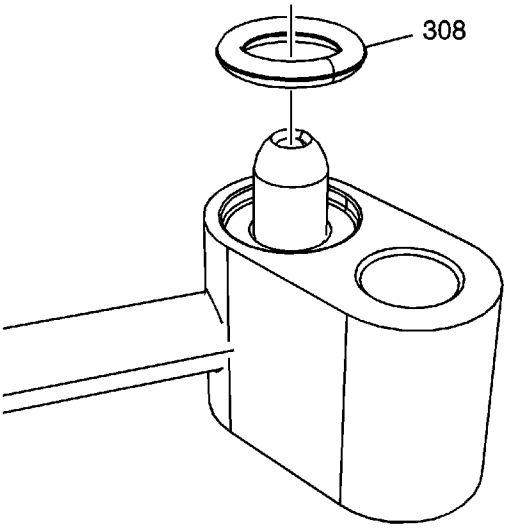


6. Use a straight edge and a feeler gage and measure the exhaust manifold cylinder head deck for warpage.

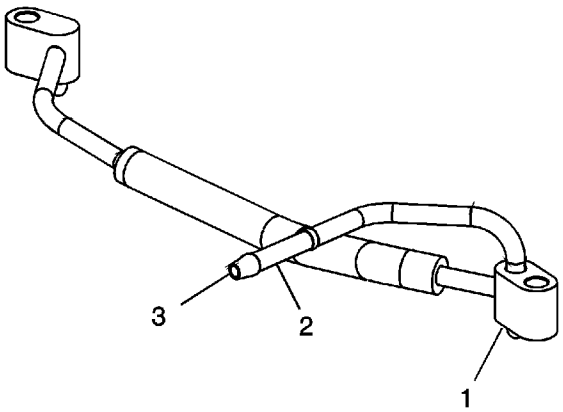
   An exhaust manifold deck with warpage in excess of **0.25 mm (0.01 in)** within the 2 front or 2 rear runners or **0.5 mm (0.02 in)** overall, may cause an exhaust leak and may effect OBD II system performance. Exhaust manifolds not within specifications must be replaced.

Engine Coolant Air Bleed Pipe and Hole Cover Cleaning and Inspection



Note: Do not use the engine coolant air bleed pipe seals again. Upon installation of the pipe, install NEW seals.

1. Remove the seals (308) from the pipe.



2. Clean the pipe in solvent.

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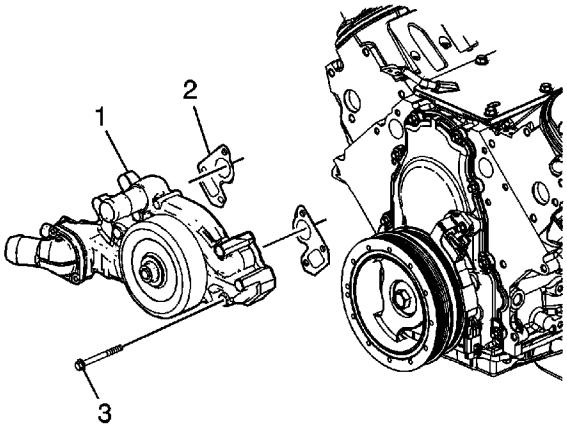
Warning: Refer to Safety Glasses and Compressed Air Warning in the Preface section.

3. Dry the pipe with compressed air.
4. Inspect the pipe for damaged sealing surfaces (1, 2) or restrictions within the pipe (3).

Water Pump Cleaning and Inspection



1. Remove the old gasket from the water pump sealing surfaces. Refer to Replacing Engine Gaskets.
2. Clean all excess dirt and debris from the water pump housing.
3. Inspect the water pump (1) for the following conditions:
   - Gasket and hose sealing surfaces for excessive scratches or gouging
   - Restrictions within the internal coolant passages
   - Excessive side-to-side play in the pulley shaft
   - Leakage at the water inlet housing or rear cover gasket
   - Leakage at the water pump vent hole
   - A stain around the vent hole is acceptable. If leakage, dripping, occurs with the engine running and the cooling system pressurized, replace the water pump.
   - Wear or damage in the belt tracking area of the pulley

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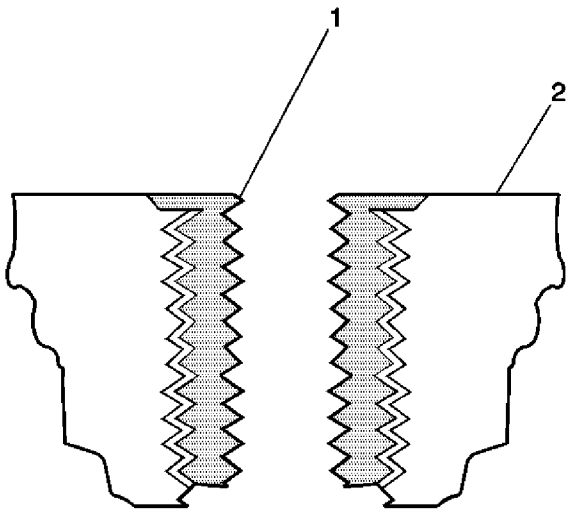
Thread Repair

Special Tools

- *J 42385-100* Head/Main Bolt Thread Repair Kit
- *J 42385-200* Common Thread Repair Kit
- *J 42385-300* Fixtures and Hardware Kit

For equivalent regional tools, refer to Special Tools.

General Thread Repair



The thread repair process involves a solid, thin walled, self-locking, carbon steel, bushing type insert (1). During the bushing installation process, the driver tool expands the bottom external threads of the insert into the base material (2). This action mechanically locks the insert in place. Also, when installed to the proper depth, the flange of the insert will be seated against the counterbore of the repaired hole.

Warning: Refer to Safety Glasses Warning in the Preface section.

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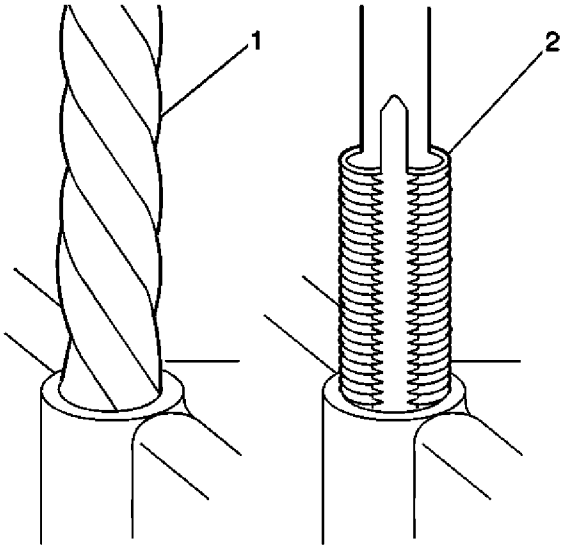
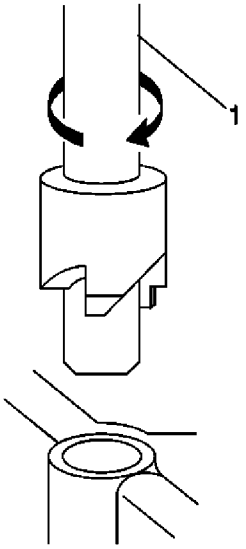


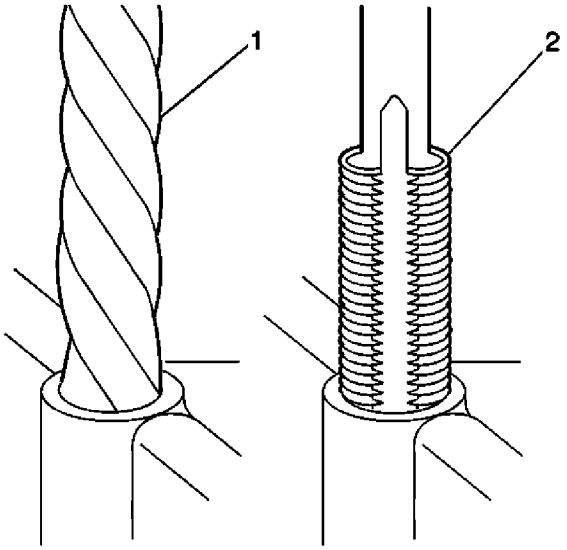
Note:

- The use of a cutting type fluid GM P/N 1052864 (Canadian P/N 992881), WD 40®, or equivalent, is recommended when performing the drilling, counterboring, and tapping procedures.
- Driver oil MUST be used on the installer driver tool.
- The tool kits are designed for use with either a suitable tap wrench or drill motor.

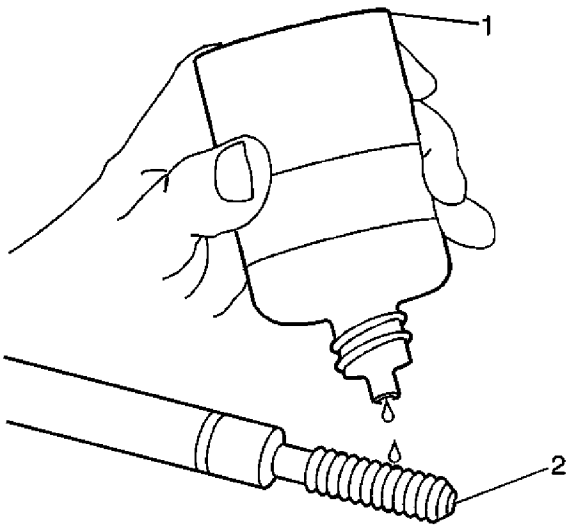
1. Drill out the threads of the damaged hole (1).
   - M6 inserts require a minimum drill depth of **15 mm (0.59 in)**.
   - M8 inserts require a minimum drill depth of **20 mm (0.79 in)**.
   - M10 inserts require a minimum drill depth of **23.5 mm (0.93 in)**.
2. Using compressed air, clean out any chips.



3. Counterbore the hole to the full depth permitted by the tool (1).
4. Using compressed air, clean out any chips.

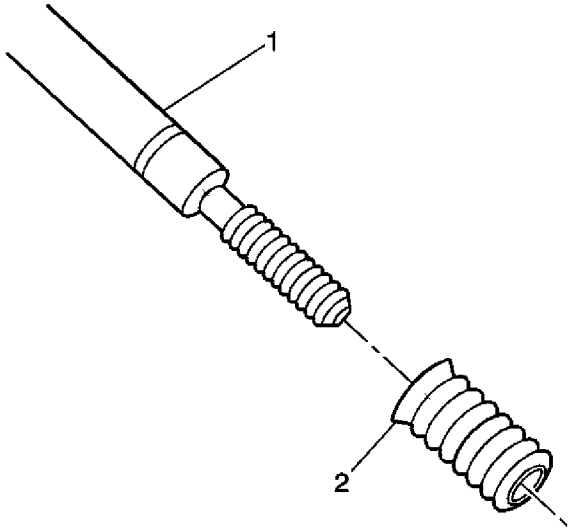


5. Using a tap wrench (2), tap the threads of the drilled hole.
   - M6 inserts require a minimum tap depth of **15 mm (0.59 in)**.
   - M8 inserts require a minimum tap depth of **20 mm (0.79 in)**.
   - M10 inserts require a minimum tap depth of **23.5 mm (0.93 in)**.
6. Using compressed air, clean out any chips.
7. Spray cleaner GM P/N 12346139, GM P/N 12377981 (Canadian P/N 10953463), or equivalent, into the hole.
8. Using compressed air, clean any cutting oil and chips out of the hole.

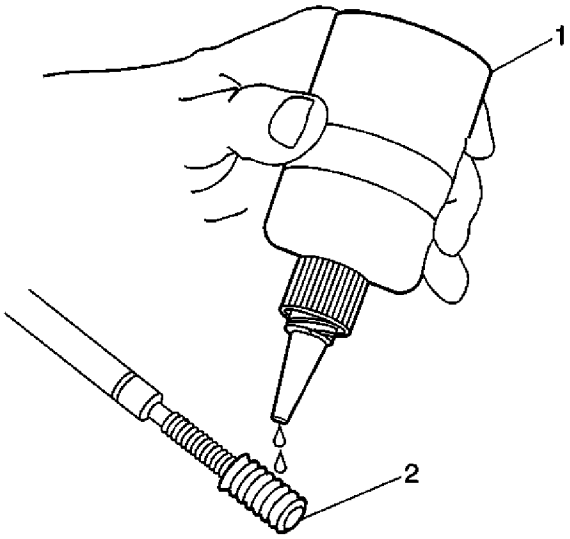


Note: Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.

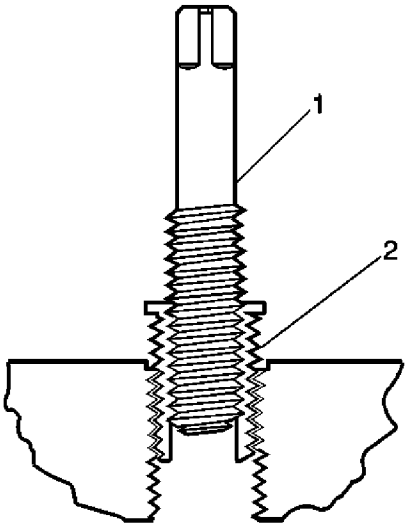
9. Lubricate the threads of the installer tool (2) with the driver oil (1).



10. Install the insert (2) onto the driver tool (1).



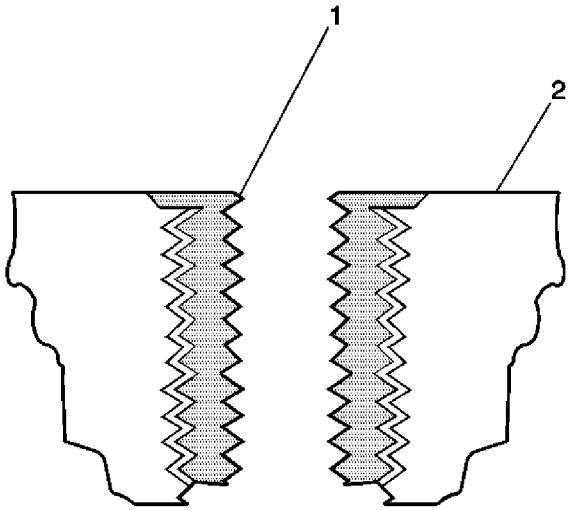
11. Apply threadlock LOCTITE™ 277, J 42385-109 (1), or equivalent, to the insert OD threads (2).



12. Install the insert (2) into the hole.

    Install the insert until the flange of the insert contacts the counterbored surface. Continue to rotate the installer tool (1) through the insert.

    The installer tool will tighten up before screwing completely through the insert. This is acceptable. You are forming the bottom threads of the insert and mechanically locking the insert to the base material threads.

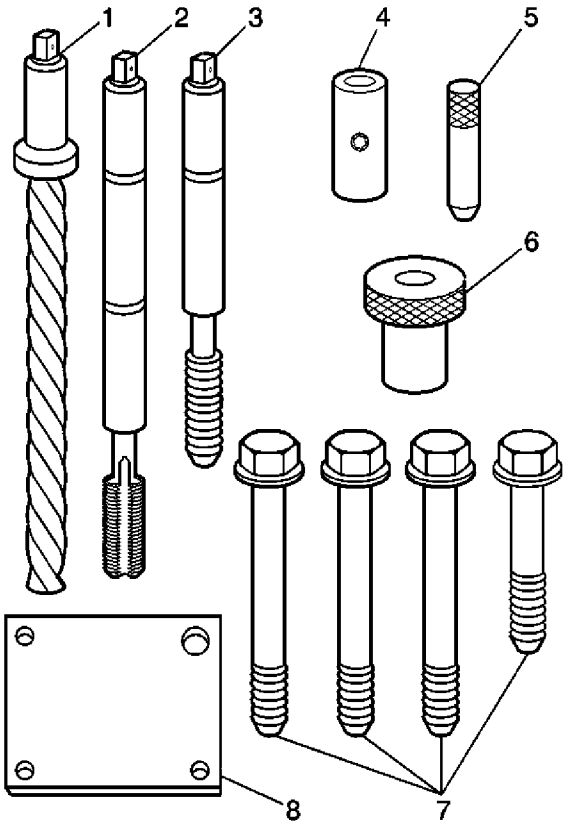


13. Inspect the insert for proper installation into the hole.

    A properly installed insert (1) will be either flush or slightly below flush with the surface of

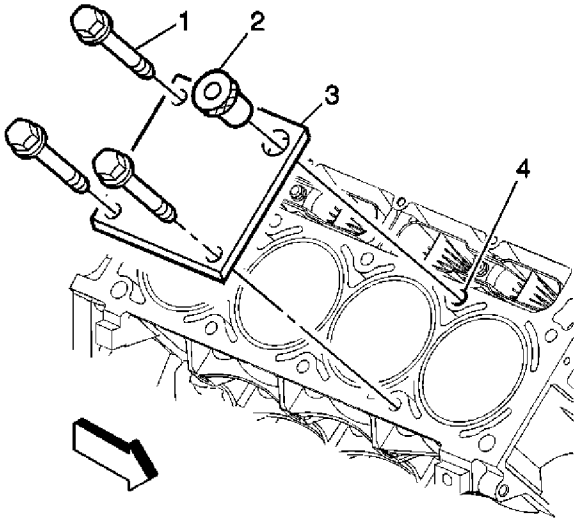
the base material (2).

Cylinder Head Bolt Hole Thread Repair



1. The cylinder head bolt hole thread repair kit consists of the following items:
   - The drill (1)
   - The tap (2)
   - The installer (3)
   - The sleeve (4)
   - The alignment pin (5)
   - The bushing (6)
   - The bolts (7)
   - The fixture plate (8)

Warning: Refer to Safety Glasses Warning in the Preface section.

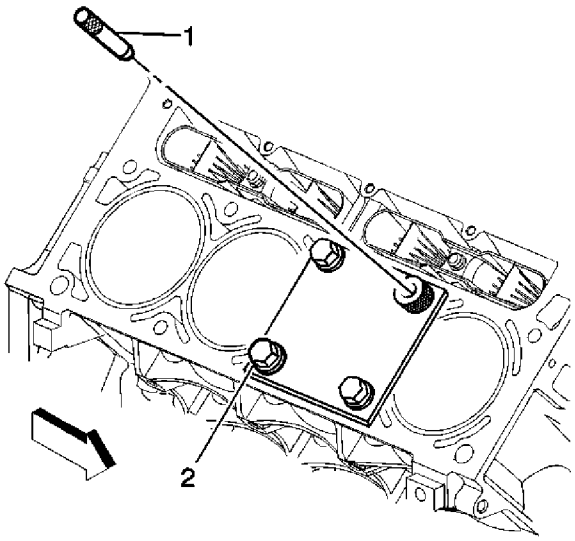


Note:

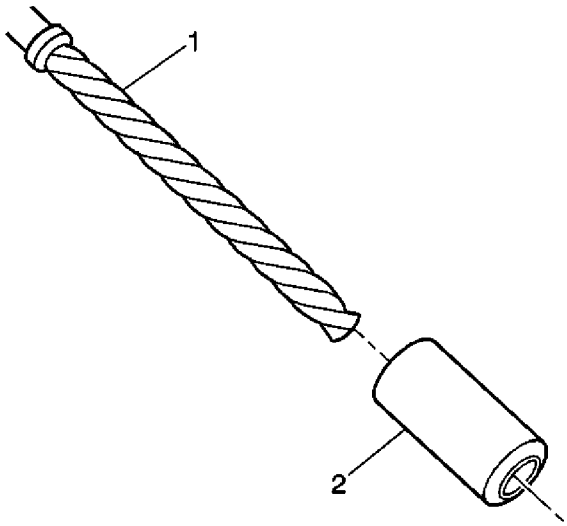
- The use of a cutting type fluid GM P/N 1052864 (Canadian P/N 992881), WD 40®, or equivalent, is recommended when performing the drilling and tapping procedures.
- Driver oil MUST be used on the installer driver tool.
- The tool kits are designed for use with either a suitable tap wrench or drill motor.

2. Install the fixture plate (3), bolts (1), and bushing (2) onto the engine block deck.

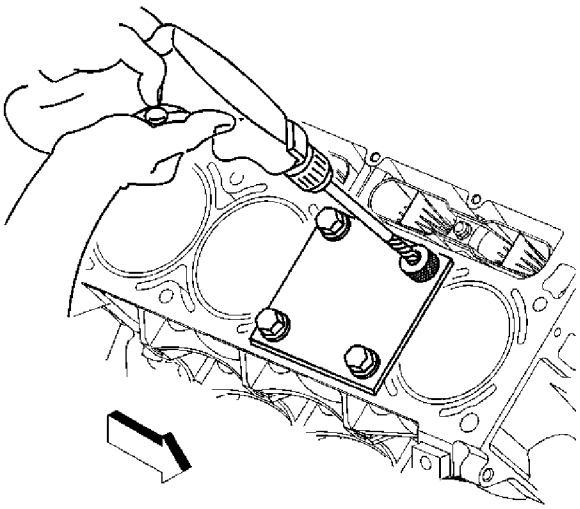
   Position the fixture plate and bushing over the hole that is to be repaired (4).



3. Position the alignment pin (1) through the bushing and into the hole.
4. With the alignment pin in the desired hole, tighten the fixture retaining bolts (2).
5. Remove the alignment pin from the hole.



6. Install the sleeve (2) onto the drill (1).

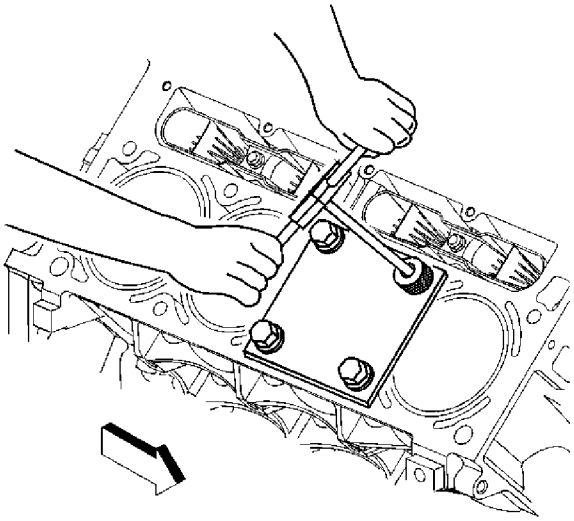


Note: During the reaming process, it is necessary to repeatedly remove the drill and clean the chips from the hole.

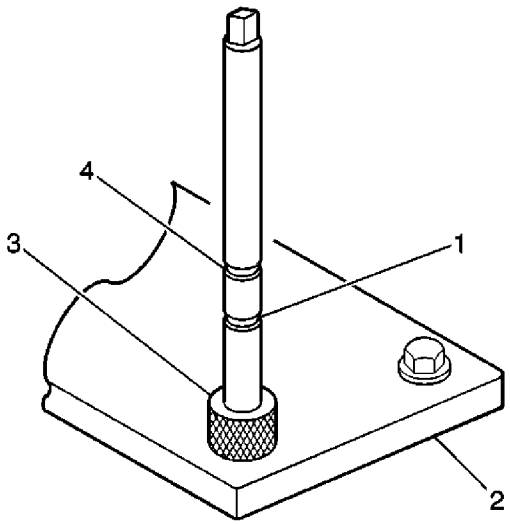
7. Drill out the threads of the damaged hole.

   Drill the hole until the stop collar of the drill bit or the sleeve contacts the bushing.

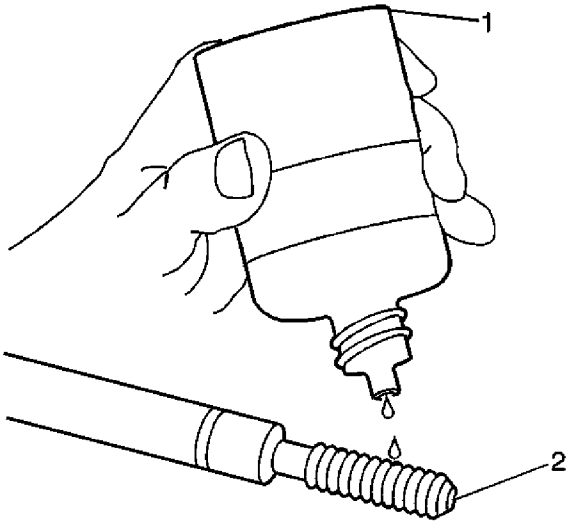
8. Using compressed air, clean out any chips.



9. Using a tap wrench, tap the threads of the drilled hole.

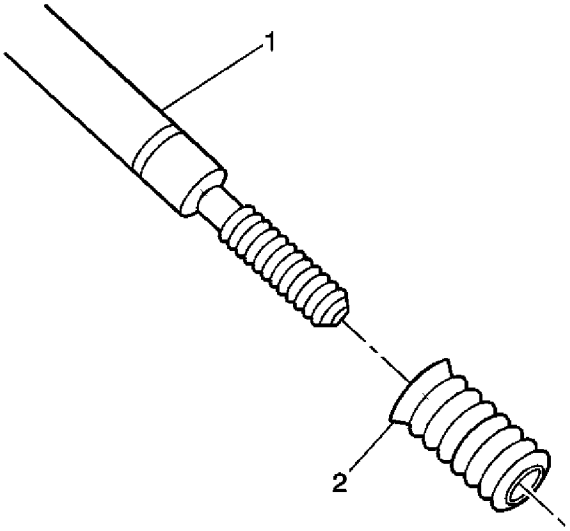


10. In order to tap the new threads to the proper depth, rotate the tap into the hole until the mark (1) on the tap aligns with the top of the drill bushing (3).
11. Remove the fixture plate (2), bushing (3), and bolts.
12. Using compressed air, clean out any chips.
13. Spray cleaner GM P/N 12346139, GM P/N 12377981 (Canadian P/N 10953463), or equivalent, into the hole.
14. Using compressed air, clean any cutting oil and chips out of the hole.

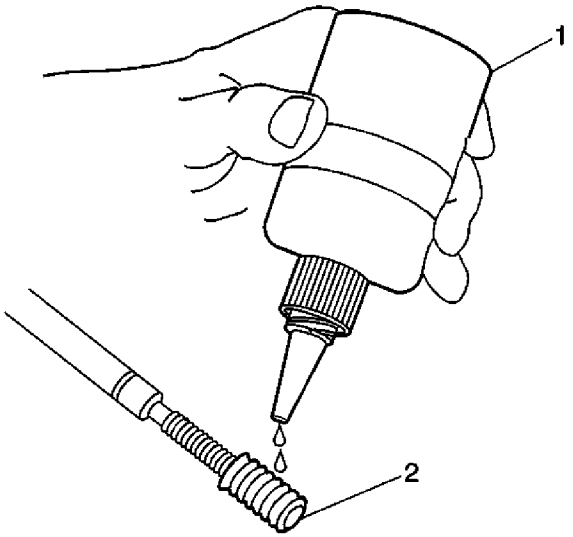


Note: Do not allow oil or foreign material to contact the OD of the insert.

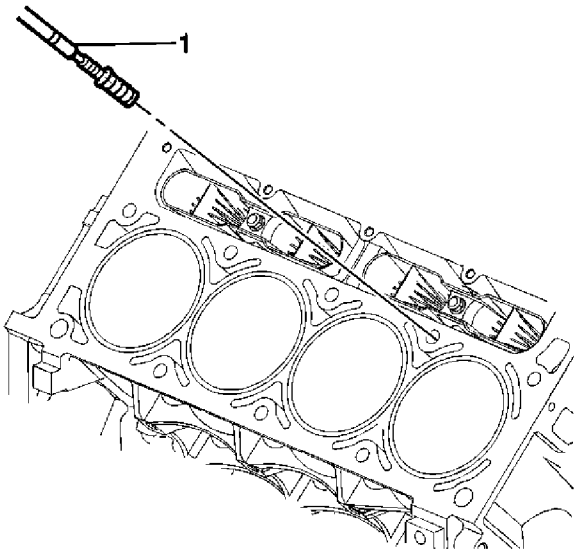
15. Lubricate the threads of the installer tool (2) with the driver oil (1).



16. Install the insert (2) onto the driver tool (1).



17. Apply threadlock LOCTITE™ 277, J 42385-109 (1), or equivalent, to the insert OD threads (2).

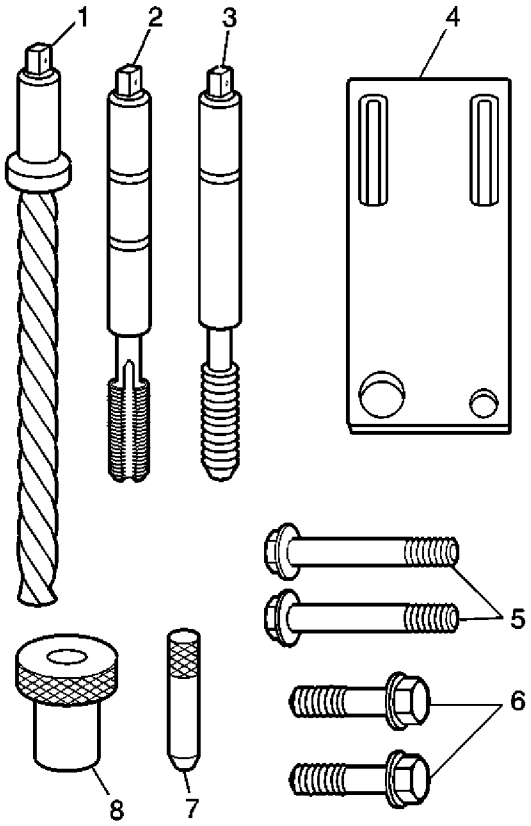


18. Install the insert and driver (1) into the hole.

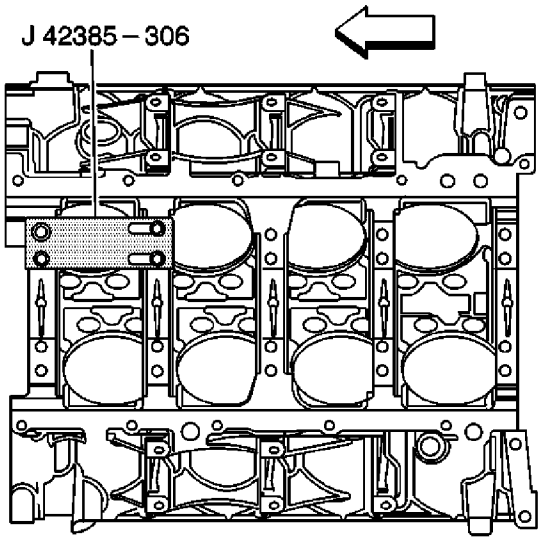
    Rotate the driver tool until the mark on the tool aligns with the deck surface of the engine block.

    The installer tool will tighten up before screwing completely through the insert. This is acceptable. You are forming the bottom threads of the insert and mechanically locking the insert to the base material threads.

Main Cap Bolt Hole Thread Repair



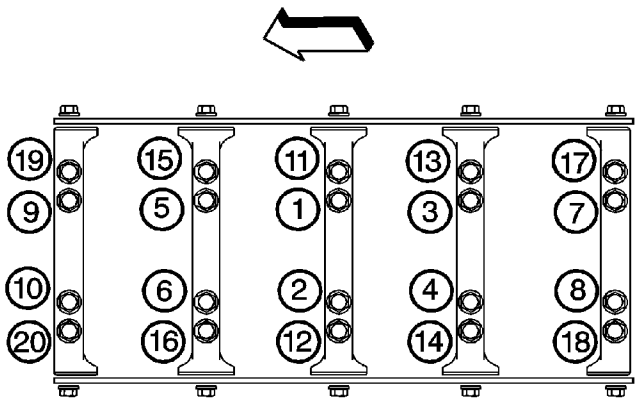
1. The main cap bolt hole thread repair kit consists of the following items:
   - The drill (1)
   - The tap (2)
   - The installer (3)
   - The fixture plate (4)
   - The long bolts (5)
   - The short bolts (6)
   - The alignment pin (7)
   - The bushing (8)



2. Install the fixture plate, bolt, and bushing onto the engine block.

   Position the fixture plate and bushing over the hole that is to be repaired.

3. Position the alignment pin in the desired hole and tighten the fixture retaining bolts.

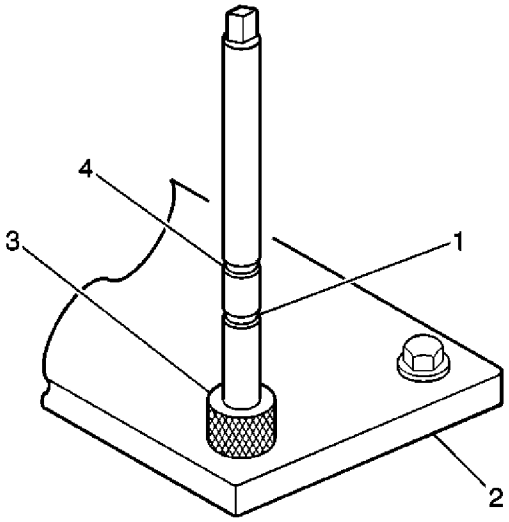


4. Drill out the damaged hole.

   The outer bolt hole locations 11-20 have the shallower counterbores. Use *J 42385-316* sleeve with the drill.

   Drill until the stop collar of the drill bit or the sleeve contacts the bushing.

5. Using compressed air, clean out any chips.



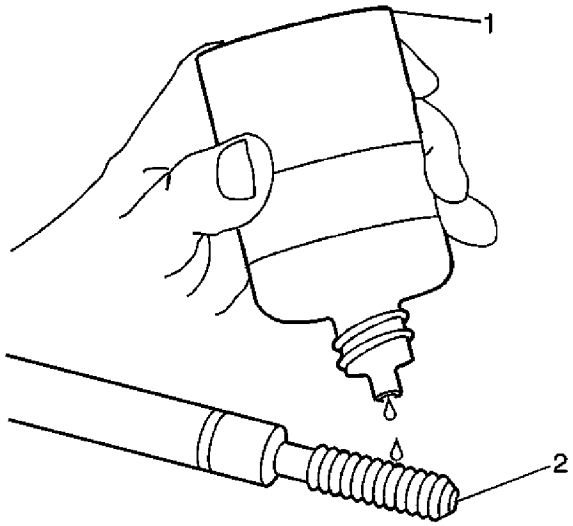
6. Using a tap wrench, tap the threads of the drilled hole.

   In order to tap the new threads to the proper depth, rotate the tap into the hole until the mark on the tap aligns with the top of the bushing.

   For the deeper main cap holes 1-10, rotate the tap until the upper mark (4) on the tap aligns with the top of the bushing (3).

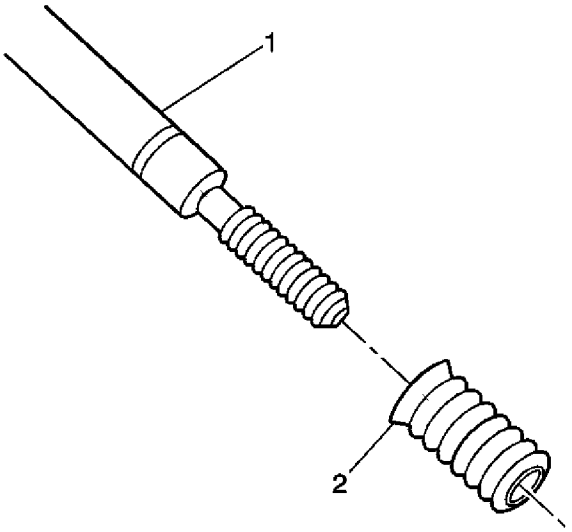
   For the shallower main cap holes 11-20, rotate the tap until the lower mark (1) on the tap aligns with top of the bushing (3).

7. Using compressed air, clean out any chips.
8. Spray cleaner GM P/N 12346139 (Canadian P/N 10953463), or equivalent, into the hole.
9. Using compressed air, clean any cutting oil and chips out of the hole.

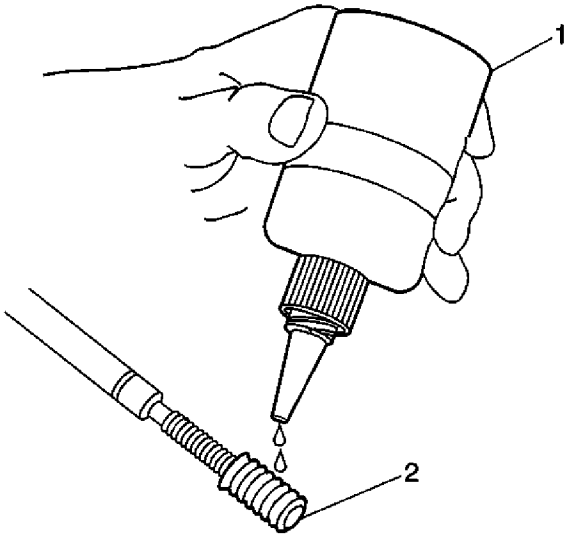


Note: Do not allow oil or foreign material to contact the OD of the insert.

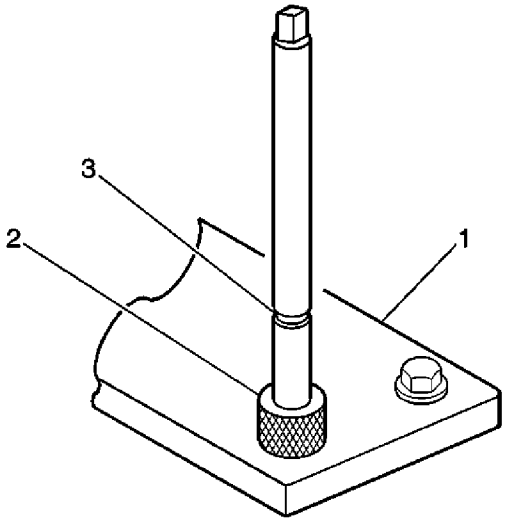
10. Lubricate the threads of the installer tool (2) with the driver oil (1).



11. Install the insert (2) onto the driver tool (1).



12. Apply threadlock LOCTITE™ 277, J 42385-109 (1), or equivalent, to the insert OD threads (2).



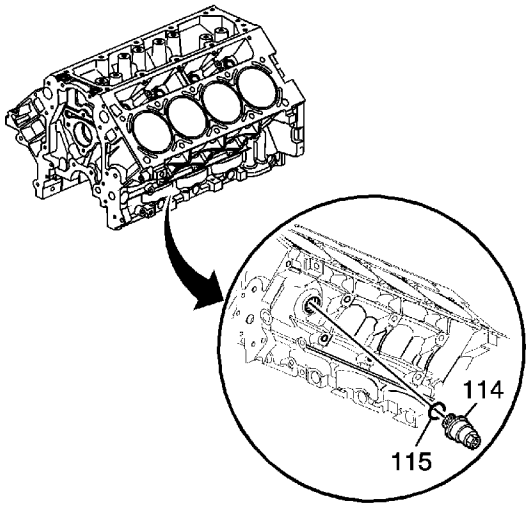
Note: The fixture plate and bushing remains installed onto the engine block during the insert installation procedure.

13. Install the insert and driver (1) through the fixture plate and bushing and into the hole.

    Rotate the driver tool until the mark on the tool (3) aligns with the top of the bushing (2).

    The installer tool will tighten up before screwing completely through the insert. This is acceptable. You are forming the bottom threads of the insert and mechanically locking the insert to the base material threads.

Engine Block Plug Installation



Note: Engine block plug, oil gallery, and coolant sealing washers may be used again if not bent, scored or otherwise damaged.

1. Apply a **3.175 mm (0.125 in)** bead of sealant GM P/N 12346004 (Canadian P/N 10953480) to the engine block coolant heater sealing washer (115), if applicable. Refer to Adhesives, Fluids, Lubricants, and Sealers.

   Caution: Refer to Fastener Caution in the Preface section.

2. Install the engine block coolant heater (114) to the engine block.

   Tighten
   Tighten the engine block coolant heater to 50 N·m (37 lb ft).

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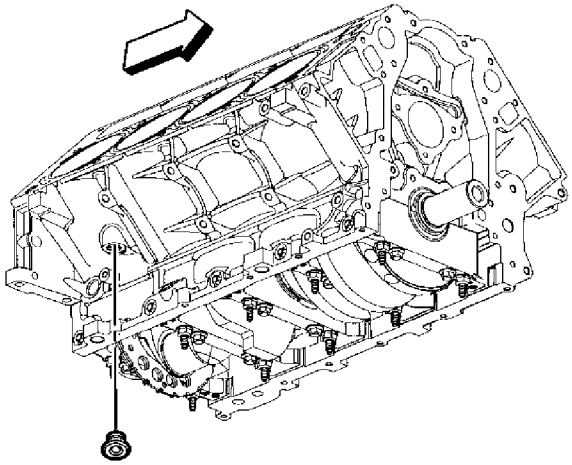
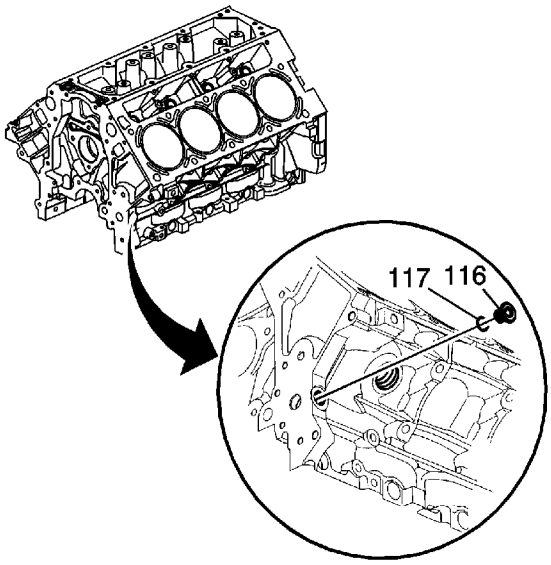


3. Apply a **3.175 mm (0.125 in)** bead of sealant GM P/N 12346004 (Canadian P/N 10953480) to the engine block right rear coolant drain hole plug sealing washer.
4. Install the engine block right rear coolant drain hole plug.

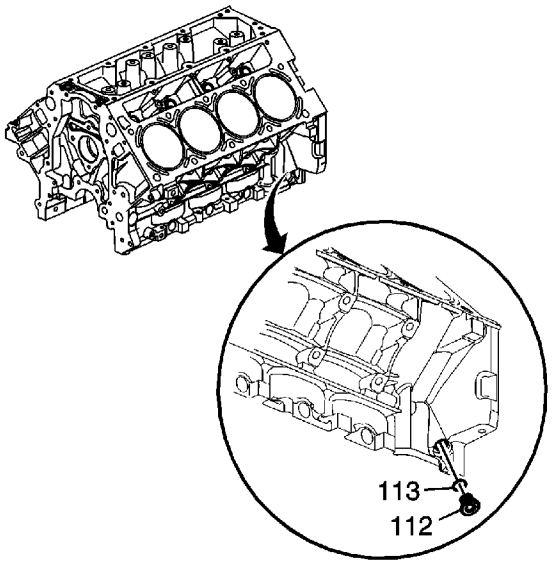
Tighten
Tighten the engine block right rear coolant drain hole plug to 60 N·m (44 lb ft).



5. Apply a **3.175 mm (0.125 in)** bead of sealant GM P/N 12346004 (Canadian P/N 10953480) to the engine block left front oil gallery plug sealing washer (117).
6. Install the engine block left front oil gallery plug (116).

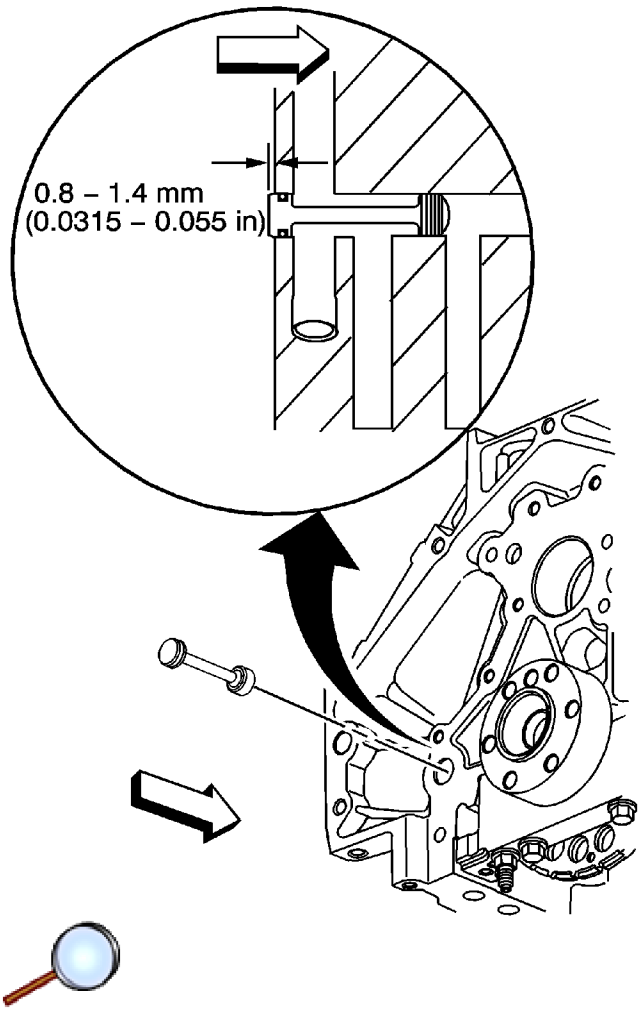
Tighten

Tighten the engine block left front oil gallery plug to 60 N·m (44 lb ft).

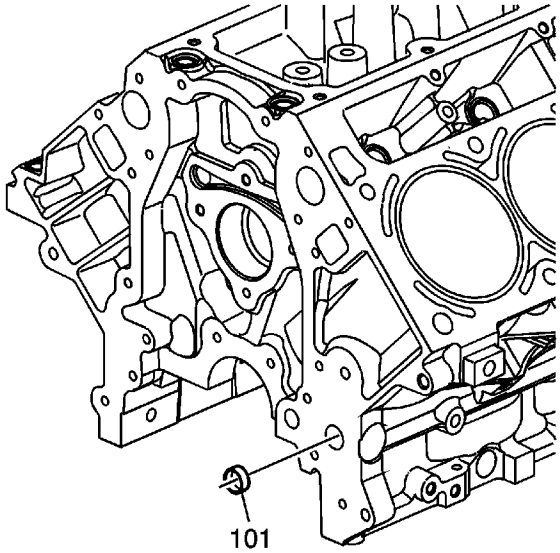


7. Apply a **3.175 mm (0.125 in)** bead of sealant GM P/N 12346004 (Canadian P/N 10953480) to the engine block left rear oil gallery plug sealing washer (113).
8. Install the engine block left rear oil gallery plug (112).

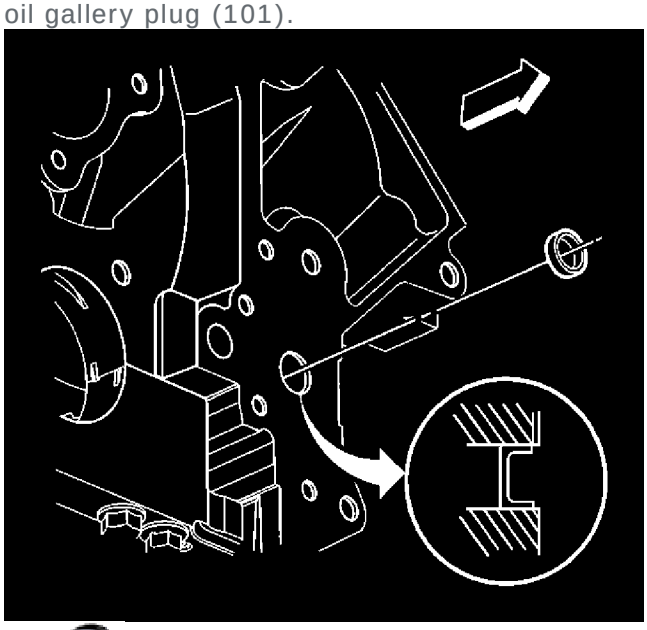
Tighten
Tighten the engine block left rear oil gallery plug to 60 N·m (44 lb ft).



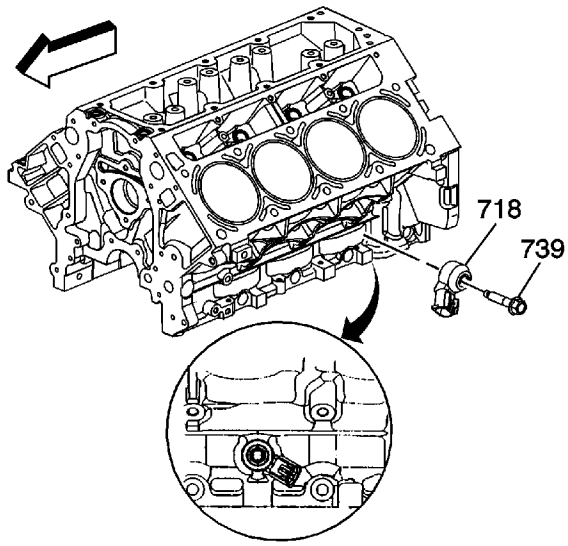
9. Inspect the engine block rear oil gallery plug and O-ring seal. If the O-ring seal on the plug is not cut or damaged, the rear oil gallery plug may be used again.
10. Lubricate the O-ring seal with clean engine oil.
11. Install the O-ring seal onto the plug.
12. Install the engine block rear oil gallery plug into the oil gallery bore. A properly installed block plug will protrude **0.8-1.4 mm (0.0315-0.055 in)** beyond the rear face of the block.



13. Apply threadlock GM P/N 12345382 (Canadian P/N 10953489) to the sides of the NEW front oil gallery plug (101).

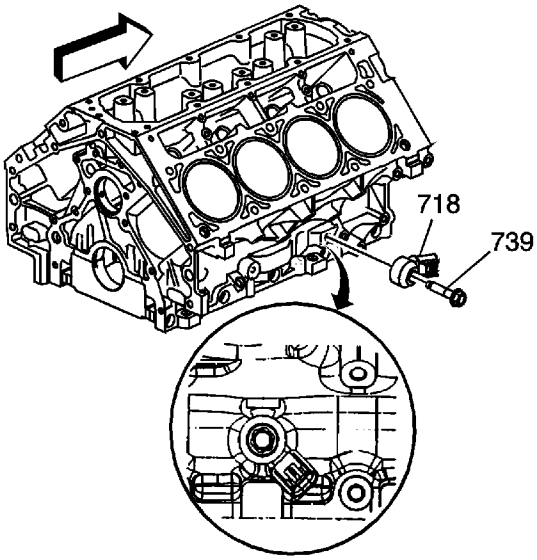


14. Install a NEW engine block front oil gallery plug. Install the plug into the oil gallery bore **2.2-2.8 mm (0.0086-0.011 in)** below flush.



15. Install the left side knock sensor (718) and bolt (739).

Tighten
Tighten the bolt to 20 N·m (15 lb ft).



16. Install the right side knock sensor (718) and bolt (739).

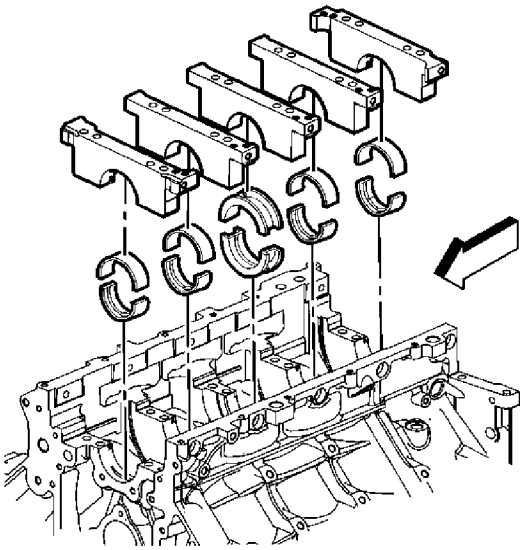
Tighten
Tighten the bolt to 20 N·m (15 lb ft).

Crankshaft and Bearing Installation

Special Tools

J 45059 Angle Meter

For equivalent regional tools, refer to Special Tools.



Note:

- Crankshaft bearing clearances are critical. Excessive crankshaft bearing clearance may affect crankshaft position (CKP) sensor signals and/or on-board diagnostic (OBD) II system performance.
- Crankshaft bearing caps must be installed to the proper location and direction.
- When installing the crankshaft bearings, align the locating tabs on the bearings with the locating notches in the engine block journal bore and the bearing cap.
- Always install crankshaft bearings with their machined partner. Do not file bearings or mix bearing halves.
- In order to prevent engine block oil leakage, install NEW M8 crankshaft bearing cap side bolts.

  The crankshaft bearing cap M8 side bolts have a pre-applied sealant patch applied to the bolt flange.

1. Install the crankshaft bearings to the engine block and bearing caps. The thrust bearings are to be installed into center journal.
2. Lubricate the bearing surfaces and crankshaft journals with clean engine oil.

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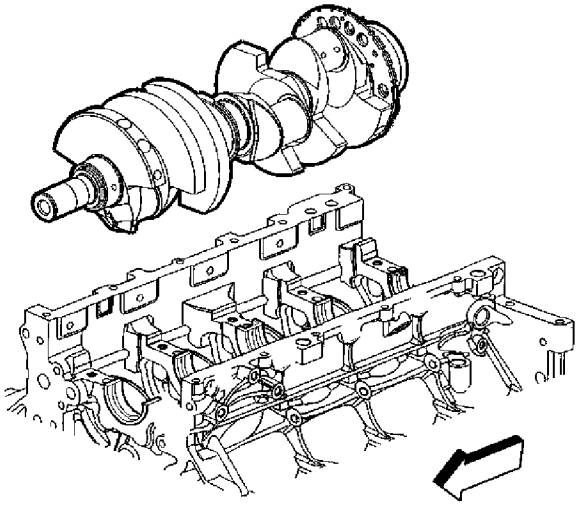
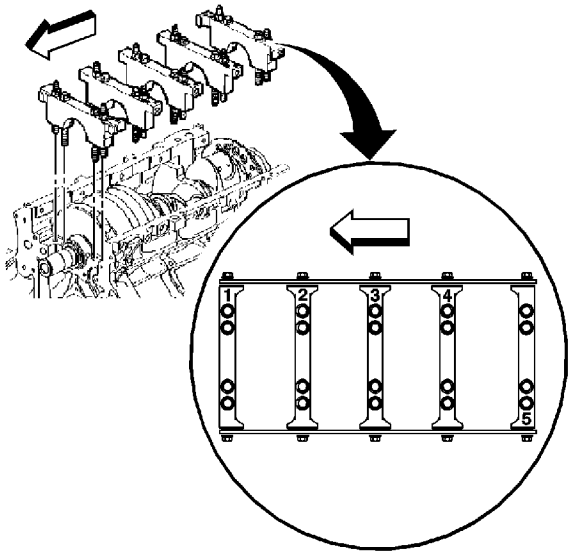


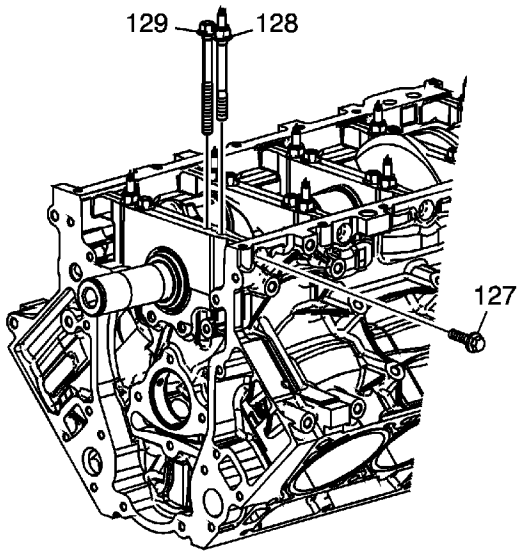
Caution: To maintain proper crankshaft end play, use extreme care during crankshaft installation. Avoid scoring or damaging the thrust bearing.

3. Install the crankshaft.



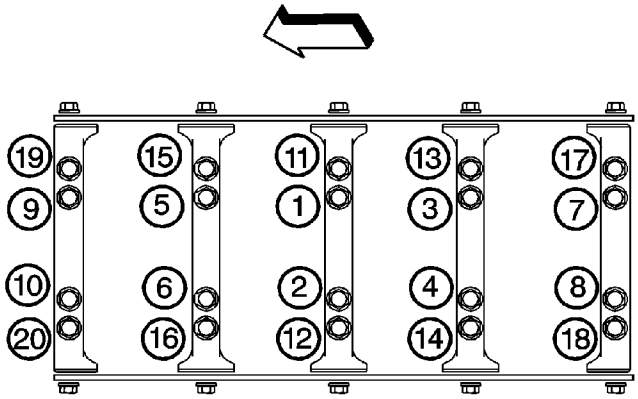
Note: The bearing caps must be installed in the proper location and direction.

4. Install the crankshaft bearing caps, with bearings, into the engine block.



5. Install the M10 bolts (129) and studs (128).
6. Using a plastic-face hammer, tap the bearing caps into place.
7. Install the NEW M8 bearing cap side bolts (127).

Caution: Refer to Fastener Caution in the Preface section.

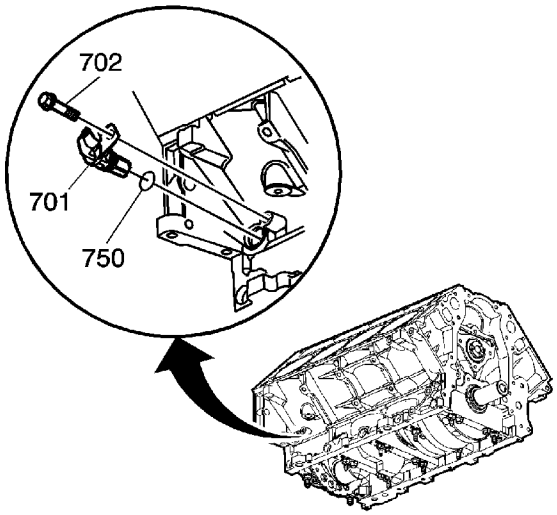


8. Tighten the bearing cap M10 bolts (1-10). Tighten the M10 bearing cap bolts (1-10) a first pass in sequence to **20 N·m (15 lb ft)**.

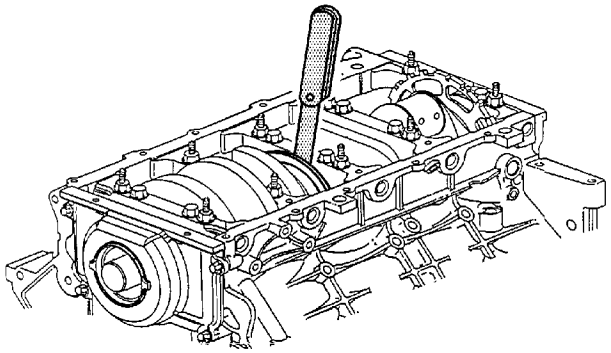
Note: To properly align the crankshaft thrust bearings, the final thrust of the crankshaft MUST be in the forward direction.

9. Using a plastic-face hammer, tap the crankshaft rearward, then forward in order to align the thrust bearings.
   9.1. Tighten the M10 bolts (1-10) a final pass in sequence **80 degrees** using the *J 45059* angle meter .
   9.2. Tighten the M10 studs (11-20) a first pass in sequence to **20 N·m (15 lb ft)**.
   9.3. Tighten the M10 studs (11-20) a final pass in sequence **51 degrees** using the *J 45059* angle meter .
   9.4. Tighten the bearing cap side M8 bolts to **25 N·m (18 lb ft)**.

   Tighten the bolt on 1 side of the bearing cap and then tighten the bolt on the opposite side of the same bearing cap.



10. Install the CKP sensor.
    10.1. Inspect the CKP sensor O-ring seal (750). If the O-ring seal is not cut or damaged, it may be used again.
    10.2. Coat the O-ring seal with clean engine oil.
    10.3. Install the O-ring onto the sensor.
    10.4. Install the sensor (701). Rotate the sensor until the locating hole in the bracket aligns with the bolt hole in the block.
    10.5. Install the sensor bolt (702). Tighten the CKP sensor bolt to **25 N·m (18 lb ft)**.



11. Measure the crankshaft end play.
    11.1. Thrust the crankshaft forward or rearward.
    11.2. Insert a feeler gage between the center crankshaft bearing and the bearing surface of the crankshaft and measure the bearing clearance.

    The proper crankshaft end play clearance is **0.04-0.2 mm (0.0015-0.0078 in)**.

    11.3. If the bearing clearance is not within specifications, inspect the thrust surfaces for nicks, gouges or raised metal. Minor imperfections may be removed with a fine stone.

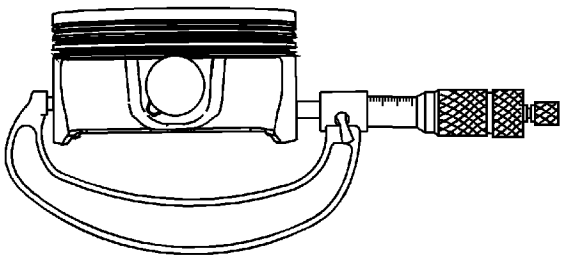
Piston, Connecting Rod, and Bearing Installation

Special Tools

- *J 8037* Piston Ring Compressor
- *J 8087* Cylinder Bore Gage
- *J 41556* Connecting Rod Guide
- *J 45059* Angle Meter

For equivalent regional tools, refer to Special Tools.

Piston Selection



Note: Measurements of all components should be taken with the components at normal room temperature. For proper piston fit, the engine block cylinder bores must not have excessive wear or taper. A used piston, pin, and connecting rod assembly may be installed if, after inspection is within specifications.

1. With a micrometer at a right angle, measure the piston outside diameter (OD). Measure the diameter **43 mm (1.69 in)** from the top of the piston. Refer to Engine Mechanical Specifications.
2. Record the piston OD.

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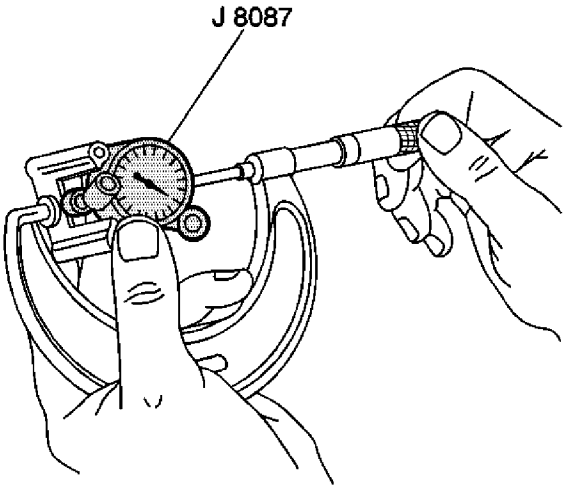
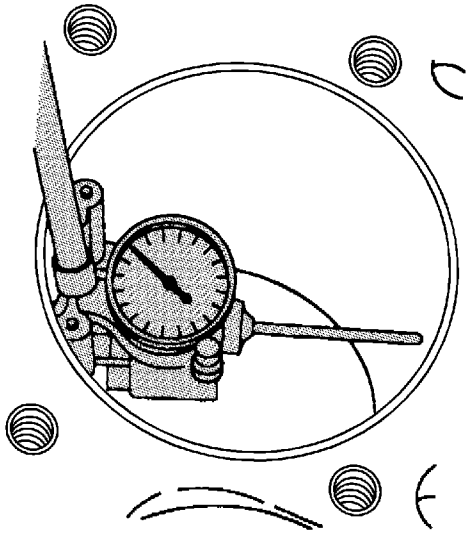
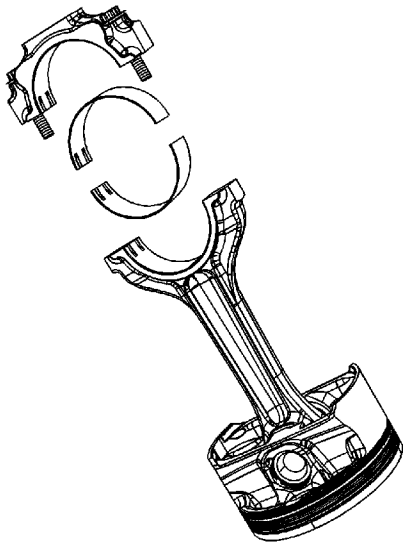


3. Adjust the micrometer to the recorded piston OD.
4. Insert the *J 8087* gage into the micrometer and zero the gage dial.

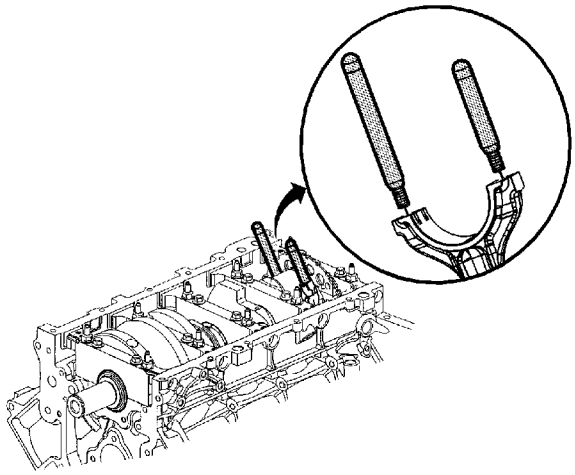


5. Using the *J 8087* gage , measure the cylinder bore inside diameter (ID). Measure at a point **64 mm (2.5 in)** from the top of the cylinder.
6. Record the cylinder bore ID.
7. Subtract the piston OD from the cylinder bore ID in order to determine the piston-to-bore clearance. Refer to Engine Mechanical Specifications.
8. If the proper clearance cannot be obtained, select another piston and pin assembly and measure the clearances again. If the proper fit cannot be obtained, the cylinder bore may require honing for an oversize piston.

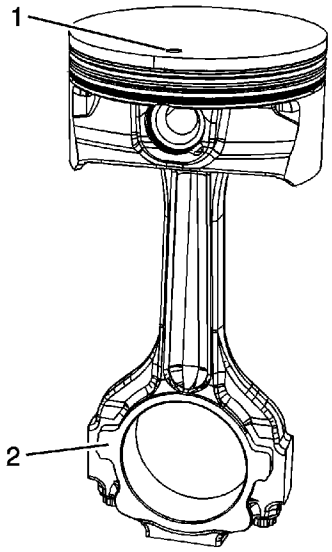
Piston, Pin, and Connecting Rod Installation



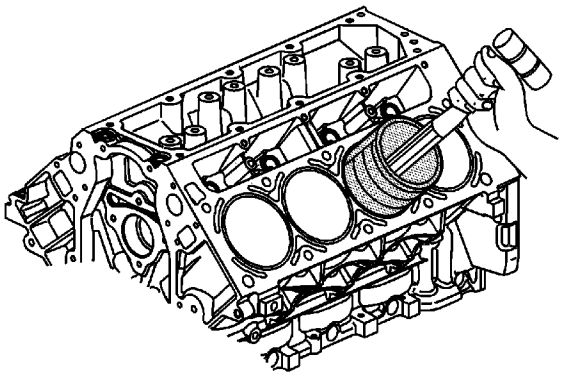
1. Lubricate the following components with clean engine oil:
   - Piston
   - Piston rings
   - Cylinder bore
   - Bearings and bearing surfaces
2. Install the bearings to the connecting rod and cap.
3. Position the oil control ring end gaps a minimum of **25 mm (1.0 in)** from each other.
4. Position the compression ring end gaps 180 degrees opposite each other.



5. Install the *J 41556* guide to the connecting rod.



6. Identify the proper installation direction of the piston and connecting rod assembly. When installing the piston and connecting rod assembly, the mark on the top of the piston (1) and the tab (2) on the side of the connecting rod should face the front of the engine.

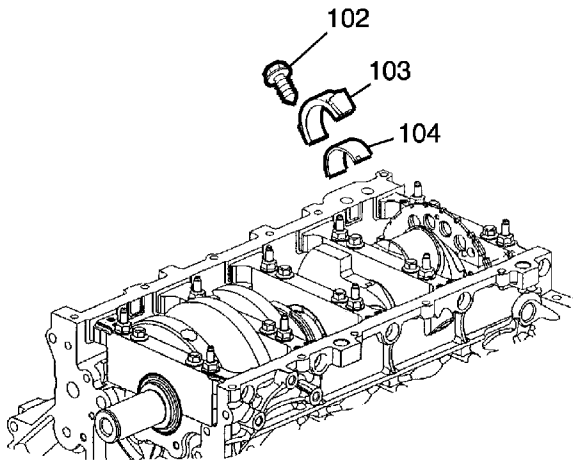


7. Install the *J 8037* compressor onto the piston and compress the piston rings.

Note: The piston alignment mark MUST face the front of the engine block.

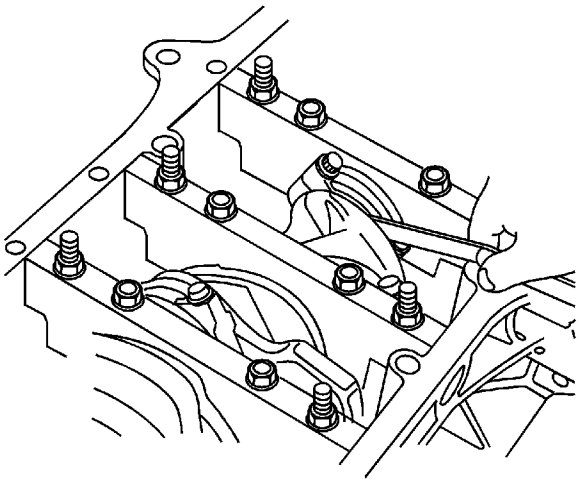
8. Install the piston, pin, and connecting rod assembly into the cylinder bore. Hold the piston ring compressor firmly against the engine block. Using a wooden hammer handle, lightly tap the top of the piston until all piston rings have entered the cylinder bore.
9. Use the *J 41556* guide to guide the connecting rod onto the crankshaft journal.
10. Remove the *J 41556* guide from the connecting rod.

Caution: Refer to Fastener Caution in the Preface section.



Note: The connecting rod and cap must be assembled with the mating surfaces properly aligned.

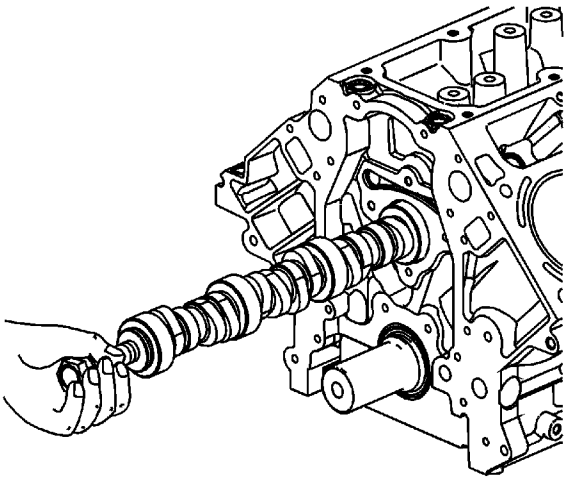
11. Install the bearing cap (103), bearing (104), and bolts (102).
    11.1. Tighten the bolts a first pass to **20 N·m (15 lb ft)**.
    11.2. Tighten the bolts a final pass to **85 degrees** using the *J 45059* meter .



12. Measure the connecting rods for the proper side clearance. Refer to Engine Mechanical

Specifications.

Camshaft Installation



Note: If camshaft replacement is required, the valve lifters must also be replaced.

1. Lubricate the camshaft journals and the bearings with clean engine oil.
2. Install the camshaft sprocket bolt into the camshaft front bolt hole.

Caution: All camshaft journals are the same diameter, so care must be used in removing or installing the camshaft to avoid damage to the camshaft bearings.

3. Using the bolt as a handle, carefully install the camshaft into the engine block.
4. Remove the bolt from the front of the camshaft.

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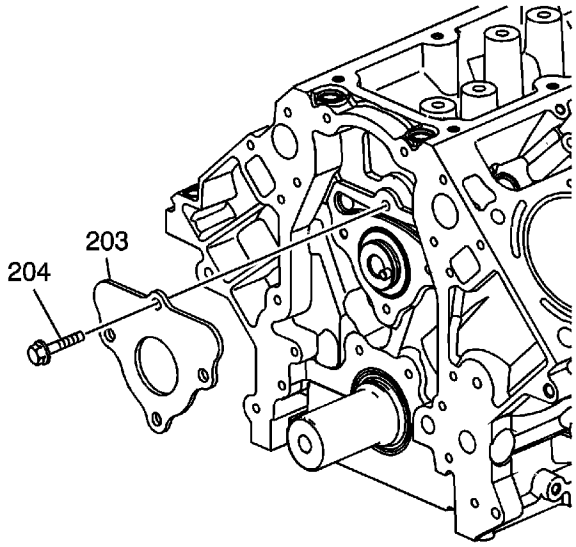
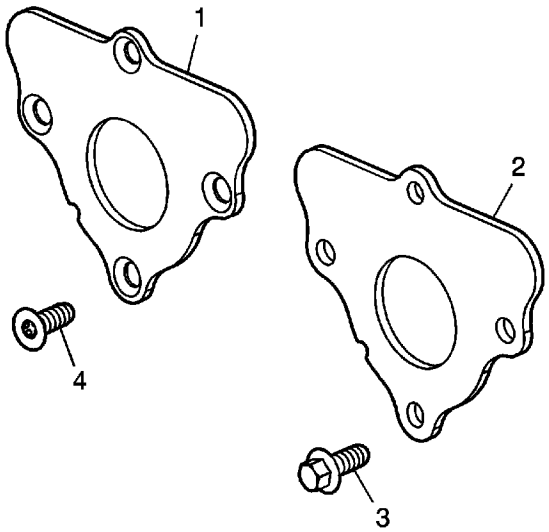


Note: The gasket surface on the engine block should be clean and free of dirt or debris.

5. Install the camshaft retainer (203) and the bolts (204). Install the retainer with the sealing gasket facing the front of the engine block.

Caution: Refer to Fastener Caution in the Preface section.



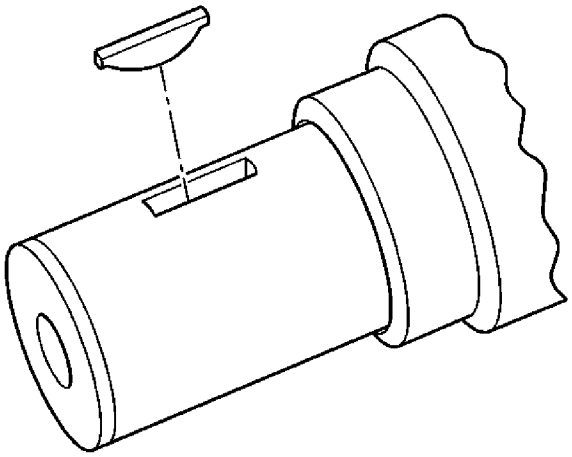
6. Tighten the camshaft retainer bolts.
   6.1. Tighten the first design hex head bolts (3) to **25 N·m (18 lb ft)**.
   6.2. Tighten the second design TORX® head bolts (4) to **15 N·m (11 lb ft)**.

Timing Chain and Sprocket Installation

Special Tools

- *EN 46330* Timing Belt Tensioner Retaining Pin
- *J 41478* Crankshaft Front Oil Seal Installer
- *J 41665* Crankshaft Balancer and Sprocket Installer
- *J 42386-A* Flywheel Holding Tool
- *J 45059* Angle Meter

For equivalent regional tools, refer to Special Tools.



1. Install the key into the crankshaft keyway, if previously removed.

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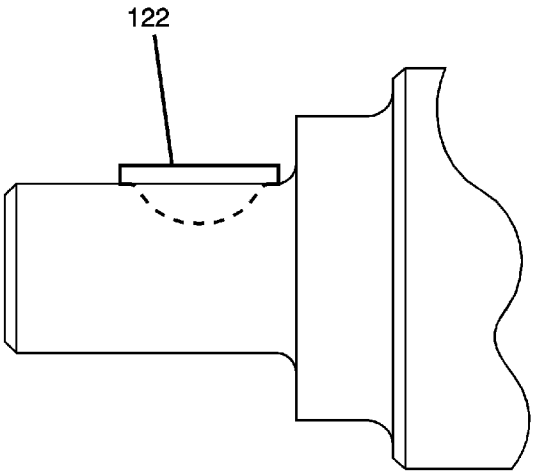
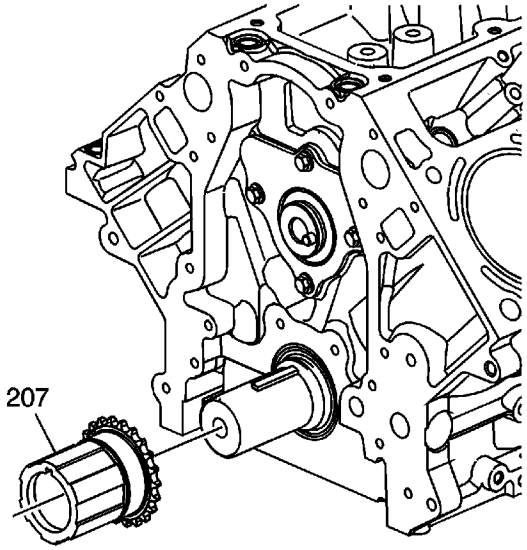
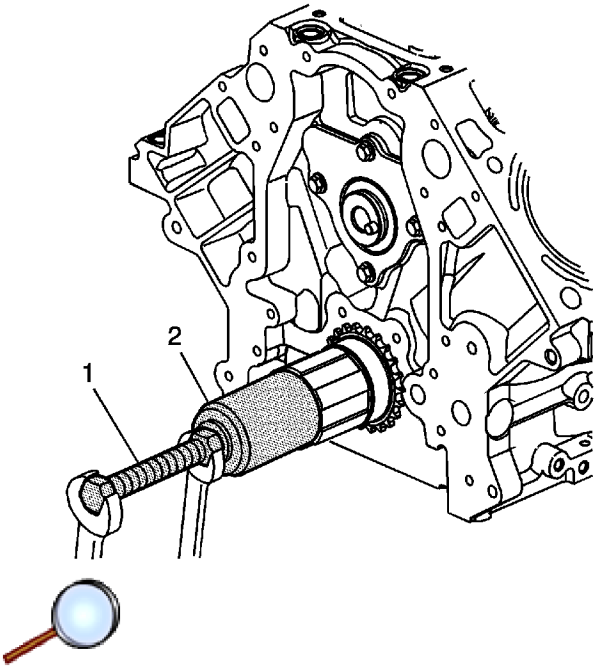


2. Tap the key (122) into the keyway until both ends of the key bottom onto the crankshaft.



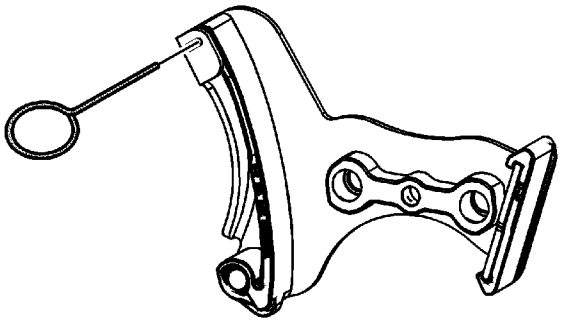
3. Install the crankshaft sprocket (207) onto the front of the crankshaft. Align the crankshaft key with the crankshaft sprocket keyway.



4. Use the *J 41478* seal installer (1) and the *J 41665* balancer and sprocket installer (2) in order to install the crankshaft sprocket.

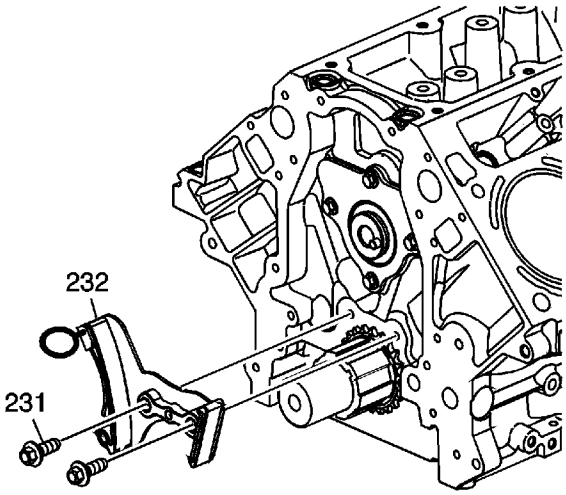
   Install the sprocket onto the crankshaft until fully seated against the crankshaft flange.

5. Rotate the crankshaft sprocket until the alignment mark is in the 12 o'clock position.

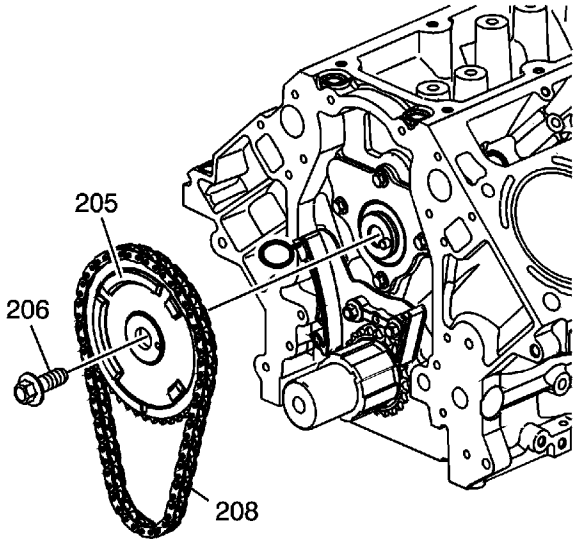


6. Compress the timing chain tensioner guide and install the *EN 46330* retaining pin .

   Caution: Refer to Fastener Caution in the Preface section.



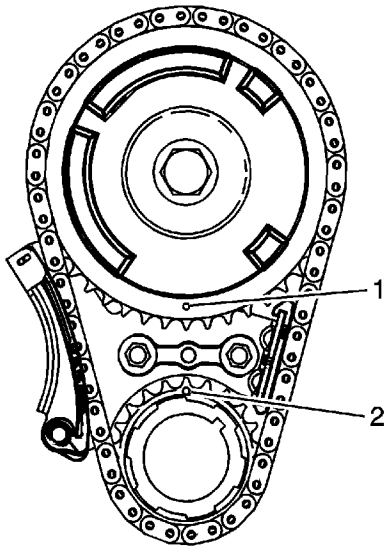
7. Install the timing chain tensioner (232) and bolts (231). Tighten the timing chain tensioner bolts to **25 N·m (18 lb ft)**.



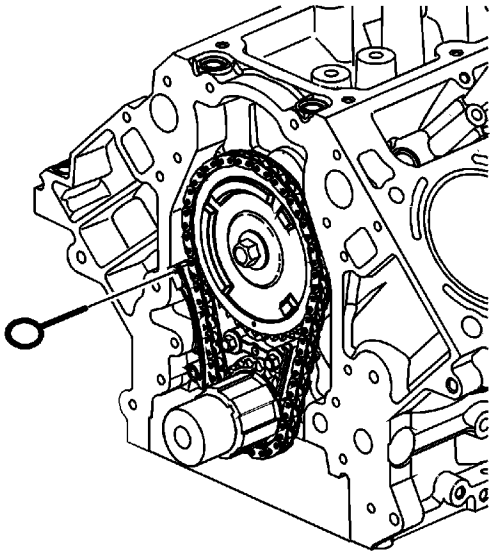
Note:

- The sprocket teeth and timing chain must mesh.
- The camshaft and the crankshaft sprocket alignment marks MUST be aligned properly.

8. Install the camshaft sprocket (205), timing chain (208), and bolt (206).



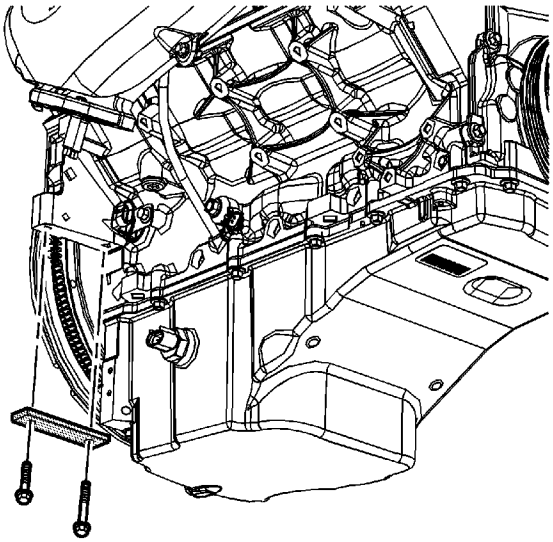
9. Inspect the sprockets for proper alignment. The mark on the camshaft sprocket (1) should be located in the 6 o'clock position and the mark on the crankshaft sprocket (2) should be located in the 12 o'clock position.



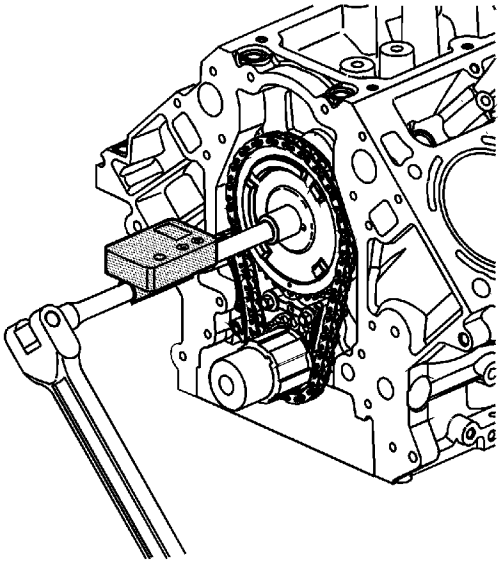
10. Remove the *EN 46330* retaining pin .

Note: Do not apply threadlock to the flex plate bolts at this time.

11. Temporarily install the automatic transmission flex plate and bolts. Refer to Automatic Transmission Flex Plate Installation.

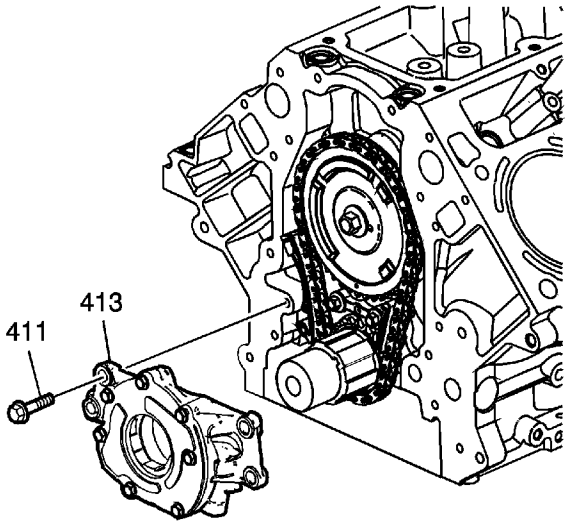


12. Install the *J 42386-A* holding tool and bolts. Use 1 M10-1.5 x 120 mm bolt and 1 M10-1.5 x 45 mm bolt for proper tool operation. Tighten the *J 42386-A* holding tool bolts to **50 N·m (37 lb ft)**.



13. Tighten the camshaft sprocket bolt.
    13.1. Tighten the camshaft sprocket bolt a first pass to **75 N·m (55 lb ft)**.
    13.2. Tighten the camshaft sprocket bolt a final pass an additional **50 degrees** using the *J 45059* meter .
14. Remove the *J 42386-A* holding tool and bolts.
15. Remove the automatic transmission flex plate and bolts. Refer to Automatic Transmission Flex Plate Removal.

Oil Pump, Screen and Crankshaft Oil Deflector Installation



Note: Inspect the oil pump and engine block oil gallery passages. These surfaces must be clear and free of debris or restrictions.

1. Align the splined surfaces of the crankshaft sprocket and the oil pump drive gear and install the oil pump (413).
2. Install the oil pump onto the crankshaft sprocket until the pump housing contacts the face of the engine block.

Caution: Refer to Fastener Caution in the Preface section.

3. Install the oil pump bolts (411) and tighten to **25 N·m (18 lb ft)**.

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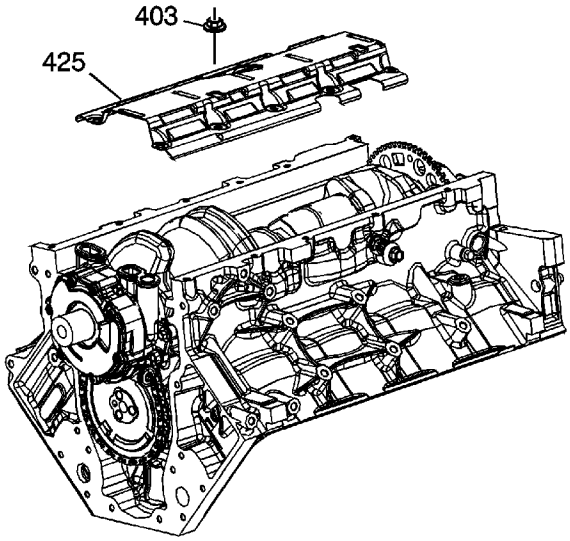
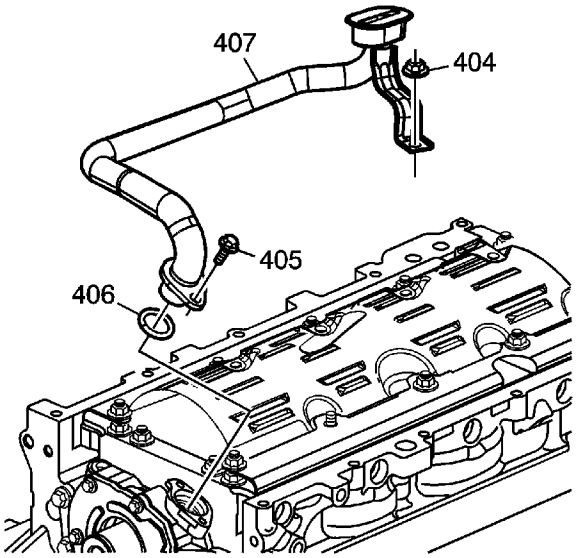


4. Install the crankshaft oil deflector.



5. Lubricate a NEW oil pump screen O-ring seal (406) with clean engine oil.
6. Install the NEW O-ring seal onto the oil pump screen.

Note:

- Push the oil pump screen tube completely into the oil pump prior to tightening the bolt. Do not allow the bolt to pull the tube into the pump.
- Align the oil pump screen mounting brackets with the correct crankshaft bearing cap bolt/studs.

7. Install the oil pump screen (407).
8. Install the oil pump screen bolt (405) and the deflector nut (404).

8.1. Tighten the oil pump screen bolt to **12 N·m (106 lb in)**.

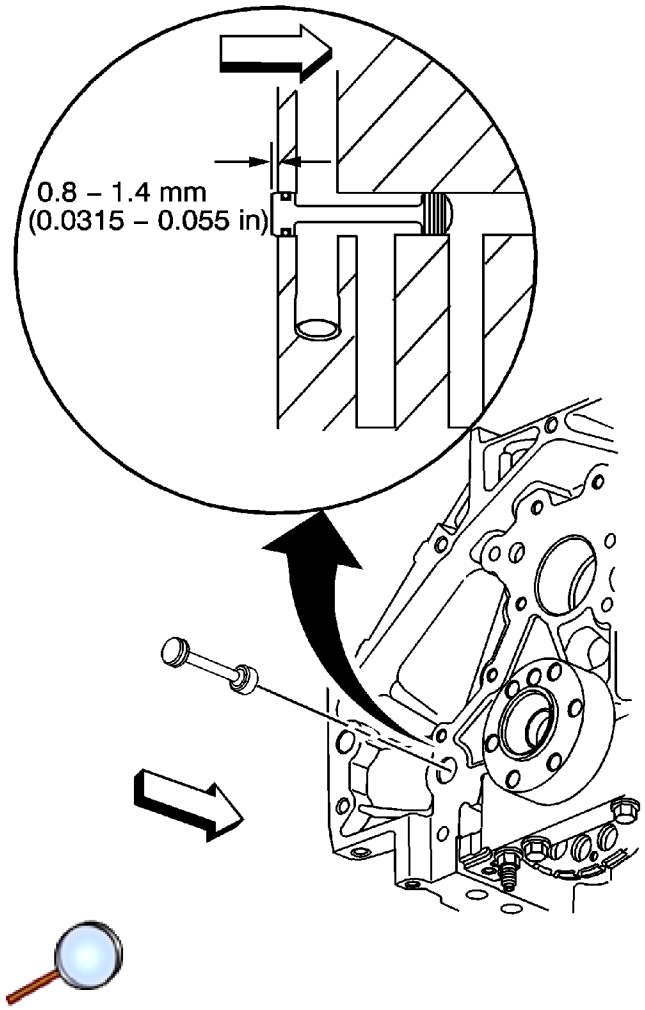
8.2. Tighten the crankshaft oil deflector nut to **25 N·m (18 lb ft)**.

Crankshaft Rear Oil Seal Housing Installation (Without Seal in Housing)

Special Tools

- *J 41476* Front and Rear Cover Alignment Tool
- *J 41480* Front and Rear Cover Alignment

For equivalent regional tools, refer to Special Tools.



Note:

- Do not use the crankshaft rear oil seal or the engine rear housing gasket again.
- Do not apply any type of sealant to the rear housing gasket, unless specified.
- The special tools in this procedure are used to properly align the engine rear housing at the oil pan surface and to center the crankshaft rear oil seal.
- The crankshaft rear oil seal will be installed after the rear housing has been installed

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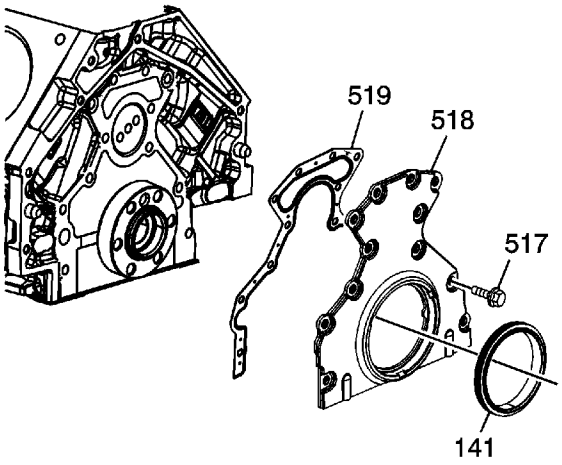
and aligned. Install the rear housing without the crankshaft oil seal.

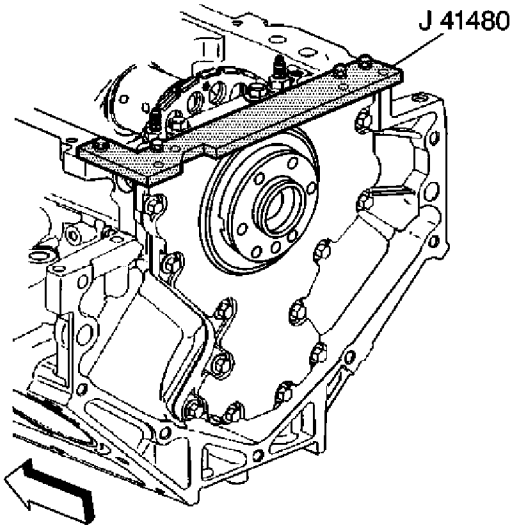
- The crankshaft rear oil seal MUST be centered in relation to the crankshaft.
- The oil pan sealing surface at the rear housing, and the engine block, MUST be aligned within specifications.
- An improperly aligned rear housing may cause premature rear oil seal wear and/or engine assembly oil leaks.

1. Inspect the rear oil gallery plug for proper installation.



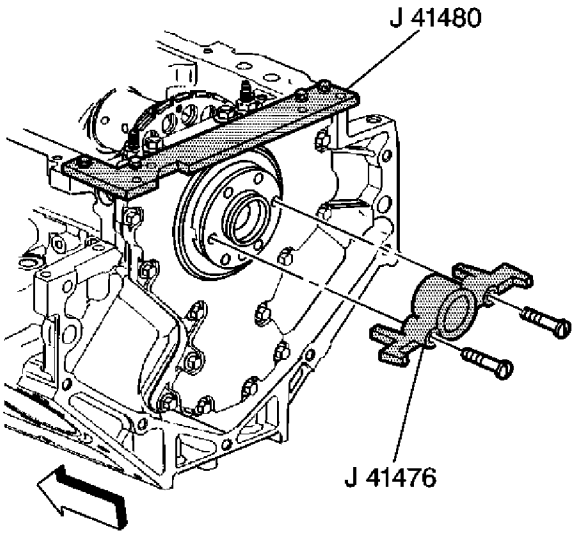
2. Install the rear housing gasket (519), rear housing (518), and bolts (517).
3. Tighten the bolts finger tight. Do not overtighten.

Caution: Refer to Fastener Caution in the Preface section.



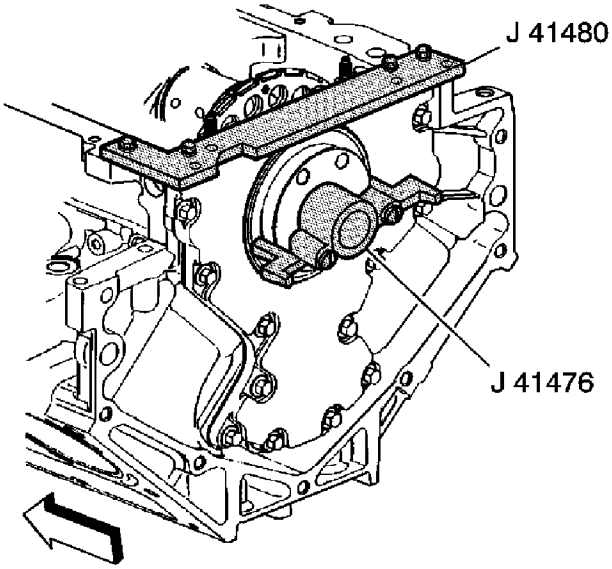
Note: Start the *J 41480* alignment tool tool-to-rear housing bolts. Do not tighten the bolts at this time.

4. Install the *J 41480* alignment tool and bolts. Tighten the tool-to-engine block bolts to **25 N·m (18 lb ft)**.



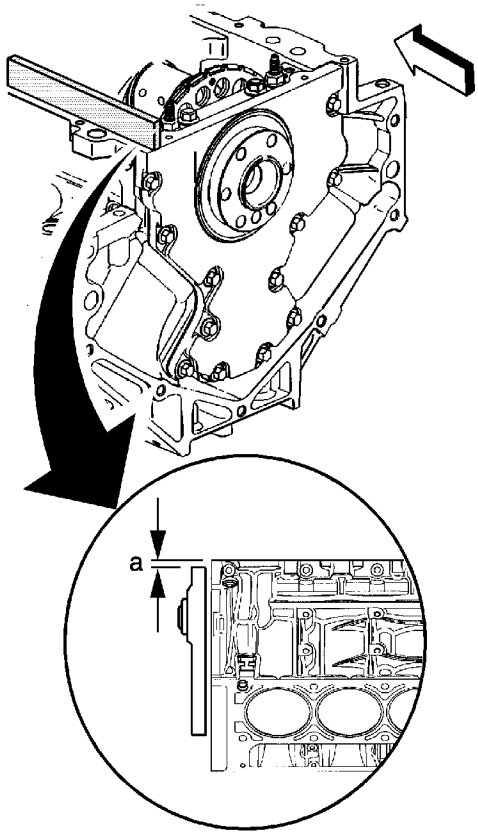
Note: To properly align the rear housing, the *J 41476* alignment tool must be installed onto the rear of the crankshaft with the tool mounting bolts parallel to the oil pan surface.

5. Rotate the crankshaft until 2 opposing flywheel bolt holes are parallel to the oil pan surface.



Note: The tapered legs of the alignment tool must enter the rear housing oil seal bore.

6. Install the *J 41476* alignment tool and bolts onto the rear of the crankshaft.
   6.1. Tighten the tool mounting bolts until snug. Do not overtighten.
   6.2. Tighten the *J 41480* alignment tool tool-to-rear housing bolts evenly to **12 N·m (106 lb in)**.
   6.3. Tighten the rear housing bolts to **30 N·m (22 lb ft)**.
7. Remove the tools.



8. Measure the rear housing-to-engine block oil pan surface for flatness.
   8.1. Place a straight edge onto the engine block and rear housing oil pan sealing surfaces.

   Avoid contact with the portion of the gasket that protrudes into the oil pan surface.

   8.2. Insert a feeler gage between the rear housing and the straight edge. The housing must be flush with the oil pan or no greater than **0.5 mm (0.02 in)** below flush.
9. If the rear housing-to-engine block oil pan surface alignment is not within specifications, repeat the housing alignment procedure.
10. If the correct rear housing-to-engine block alignment at the oil pan surface cannot be

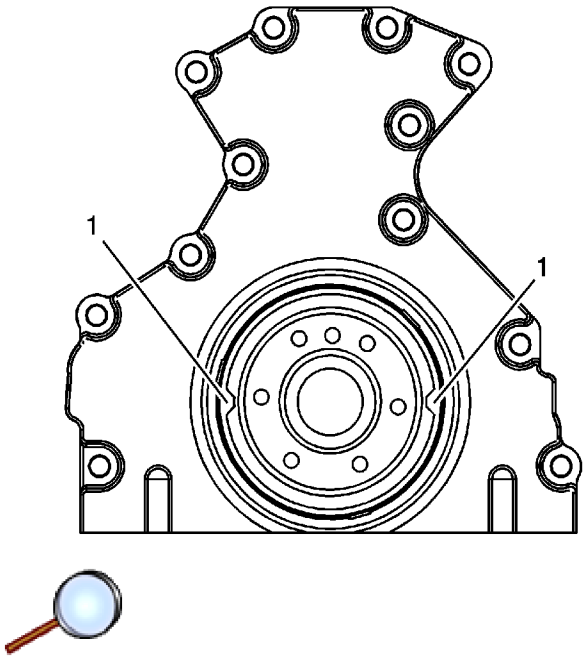
obtained, replace the rear housing.

Crankshaft Rear Oil Seal Housing Installation (With Seal in Housing)

Special Tools

- *J 41479-2A* Crankshaft Rear Oil Seal Installation Guide
- *J 41480* Front and Rear Cover Alignment

For equivalent regional tools, refer to Special Tools.



Note:

- Do not use the crankshaft rear oil seal or the engine rear housing gasket again.
- Do not apply any type of sealant to the rear housing gasket, unless specified.
- The special tool in this procedure is used to properly align the engine rear housing at the oil pan surface.
- First design rear housings do not have alignment tabs for alignment of the housing horizontally. *J 41476* alignment tool is required to properly align first design rear housings. The rear oil seal must be removed from the housing for proper use of the tool.
- Second design rear housings have alignment tabs for alignment of the housing horizontally. *J 41476* alignment tool is not required for proper alignment of second design rear housings. The housing may be installed and aligned with the seal already installed into the housing.

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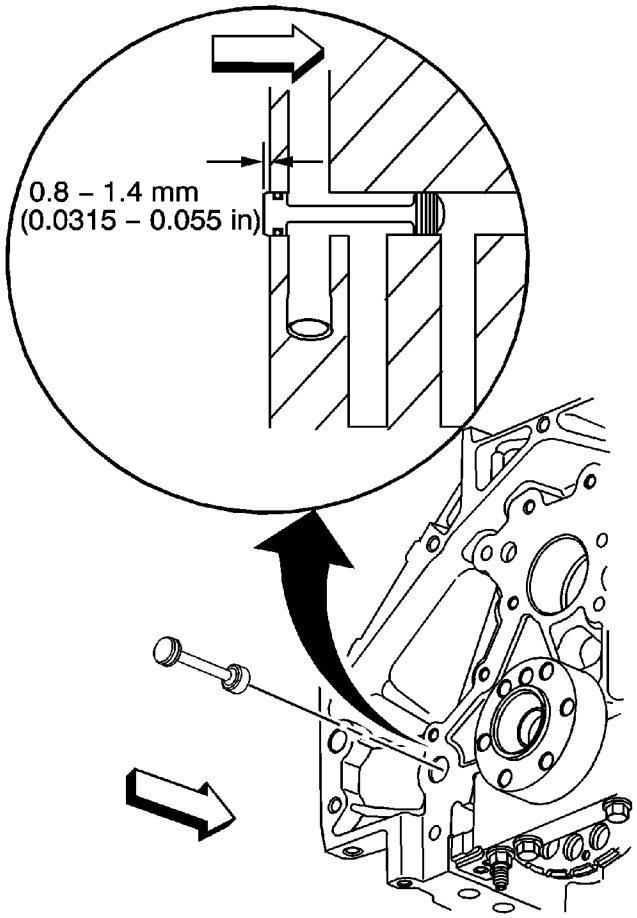
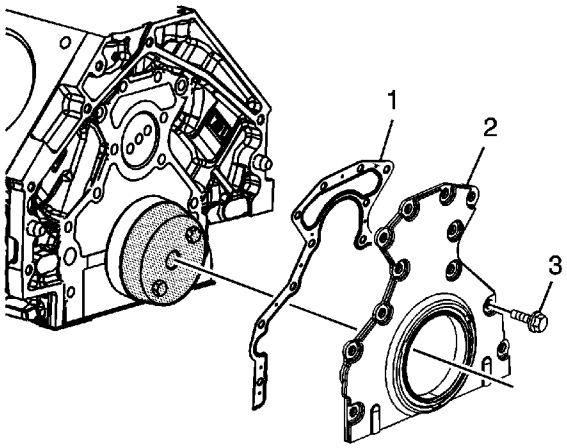
1. Inspect the rear housing to identify for alignment tabs (1).



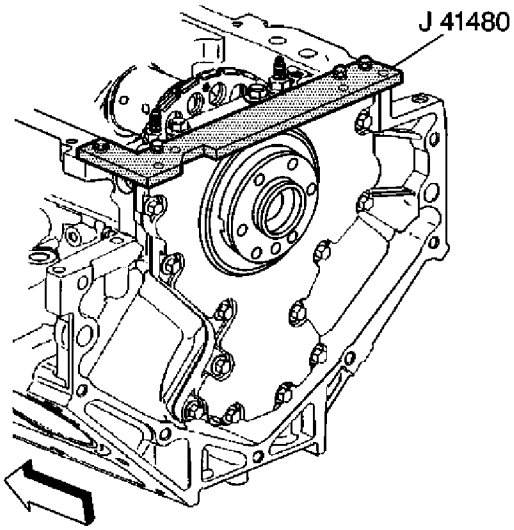
2. Inspect the rear oil gallery plug for proper installation.



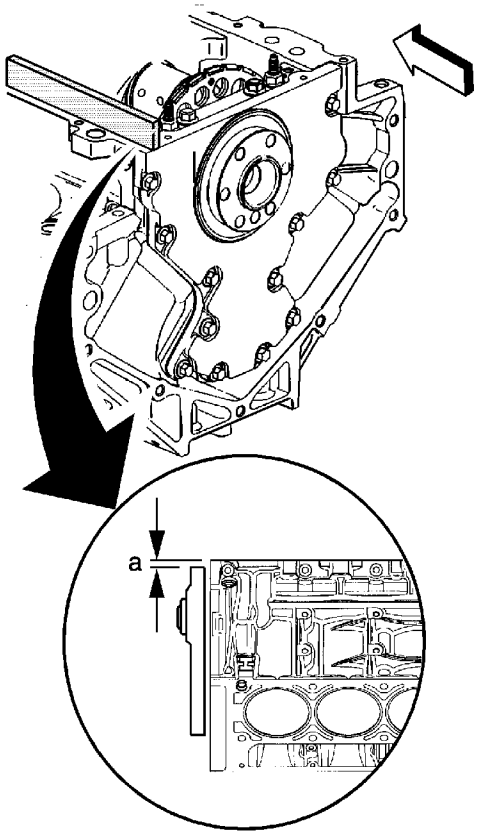
3. Install the *J 41479-2A* seal installation guide cone and bolts onto the rear of the crankshaft.
4. Tighten the bolts until snug. Do not overtighten.

5. Install the rear housing gasket (1), rear housing with seal (2), and bolts (3).
6. Tighten the bolts finger tight. Do not overtighten.
7. Remove the *J 41479-2A* seal installation guide and bolts.

Caution: Refer to Fastener Caution in the Preface section.



8. Install the *J 41480* alignment tool and bolts.
   8.1. Tighten the tool-to-engine block bolts to **25 N·m (18 lb ft)**.
   8.2. Tighten the *J 41480* alignment tool tool-to-rear housing bolts evenly to **12 N·m (106 lb in)**.
   8.3. Tighten the rear housing-to-engine block bolts to **25 N·m (18 lb ft)**.
9. Remove the *J 41480* alignment tool and bolts.



10. Measure the rear housing-to-engine block oil pan surface for flatness.
    10.1. Place a straight edge onto the engine block and rear housing oil pan sealing surfaces.

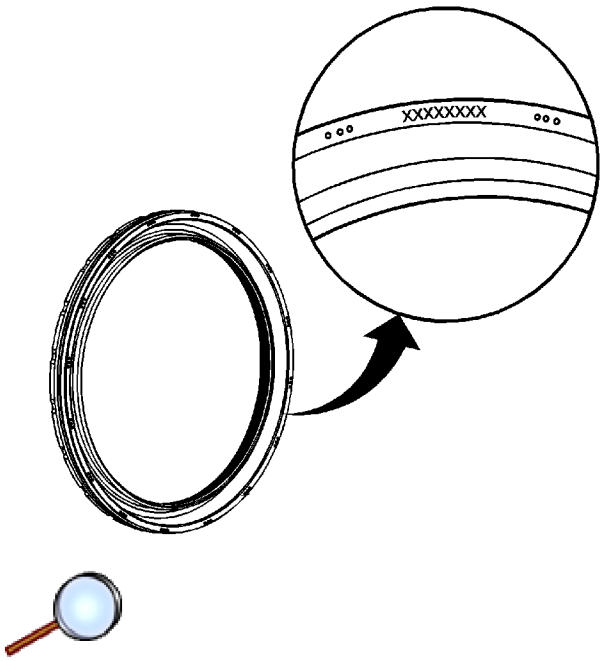
    Avoid contact with the portion of the gasket that protrudes into the oil pan surface.

    10.2. Insert a feeler gage between the rear housing and the straight edge. The housing must be flush with the oil pan or no greater than **0.5 mm (0.02 in)** below flush.
11. If the rear housing-to-engine block oil pan surface alignment is not within specifications, repeat the housing alignment procedure.
12. If the correct rear housing-to-engine block alignment at the oil pan surface cannot be obtained, replace the rear housing.

Crankshaft Rear Oil Seal Installation

Special Tools

- J 41479 Crankshaft Rear Oil Seal Installer
- J 41479-2A Crankshaft Rear Oil Seal Installation Guide



Important: For proper orientation, note the installation direction of the oil seal. The oil seal is a reverse-lip design. The part number is applied to the outside face of the seal, as shown.

1. Inspect the seal and identify the part number markings for proper orientation.

Important:
- Do not lubricate the oil seal (1) inside diameter (ID) of the crankshaft surface.
- Do not reuse the crankshaft rear oil seal (1).

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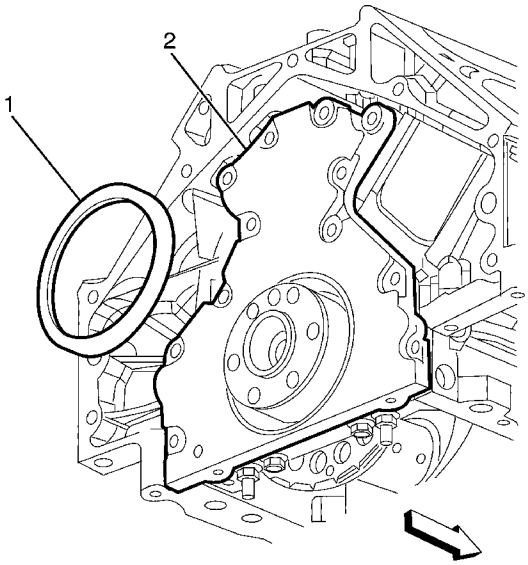
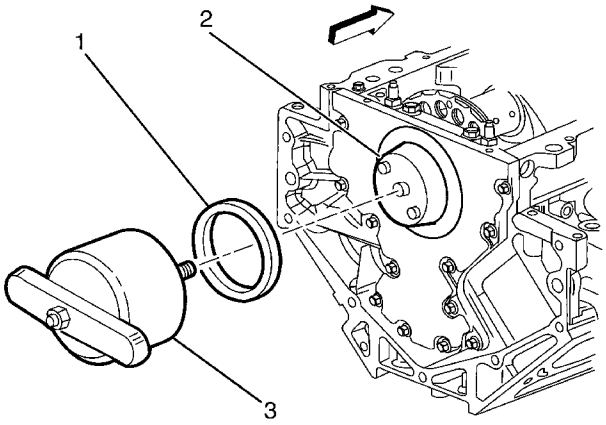


2. Lubricate the outside diameter (OD) of the oil seal (1) with clean engine oil.

   DO NOT allow oil or other lubricants to contact the seal surface.

3. Lubricate the rear cover (2) oil seal bore with clean engine oil.

   DO NOT allow oil or other lubricants to contact the crankshaft surface.



4. Install the J 41479-2A (2) cone and bolts onto the rear of the crankshaft.

   Important: Do not over tighten the bolts.

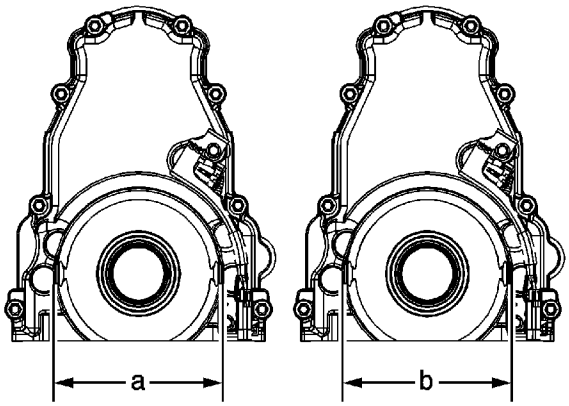
5. Tighten the bolts.
6. Install the rear oil seal (1) onto the J 41479 (3) and push the seal to the rear cover bore (2).
7. Thread the J 41479 (3) threaded rod into the tapered cone until the J 41479 (3) contacts the rear oil seal (1).
8. Align the rear oil seal (1) onto the J 41479 (3).
9. Rotate the handle of the J 41479 (3) clockwise until the rear oil seal (1) enters and bottoms into the rear cover bore (2).
10. Remove the J 41479 (3) and J 41479-2A .

Engine Front Cover Installation

Special Tools

- *EN-48853* Front Cover Alignment Tool
- *J 41480* Front and Rear Cover Alignment

For equivalent regional tools, refer to Special Tools.



1. Measure the alignment tab distance on the front cover.

   For 2009 model year, the engine front cover may have either a **141 mm (5.55 in)** dimension (a) or **159 mm (6.26 in)** dimension (b) alignment tab distance. The *EN-48853* front cover alignment tool is designed to properly align both design front covers. For the **141 mm (5.55 in)** cover, the *EN 48853-2* adapters must be used.

   Caution: Refer to Fastener Caution in the Preface section.

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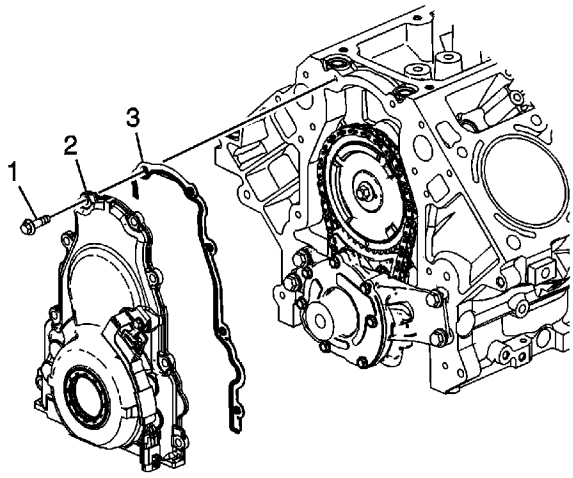
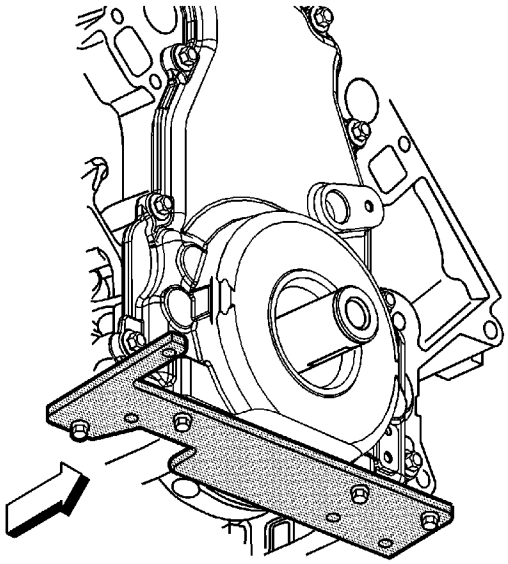


Note:

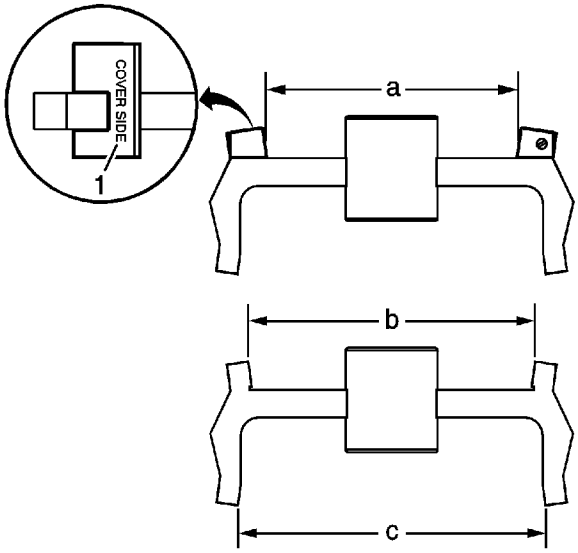
- Do not use the crankshaft oil seal or the engine front cover gasket again.
- Do not apply any type of sealant to the front cover gasket, unless specified.
- The special tools in this procedure are used to properly align the engine front cover at the oil pan surface and to center the crankshaft front oil seal.
  - All gasket surfaces should be free of oil or other foreign material during assembly.
  - The crankshaft front oil seal MUST be centered in relation to the crankshaft.
  - The oil pan sealing surface at the front cover and engine block MUST be aligned within specifications.
  - An improperly aligned front cover may cause premature front oil seal wear and/or engine assembly oil leaks.

2. Install the front cover gasket (3), front cover (2), and bolts (1).
3. Tighten the cover bolts finger tight. Do not overtighten.

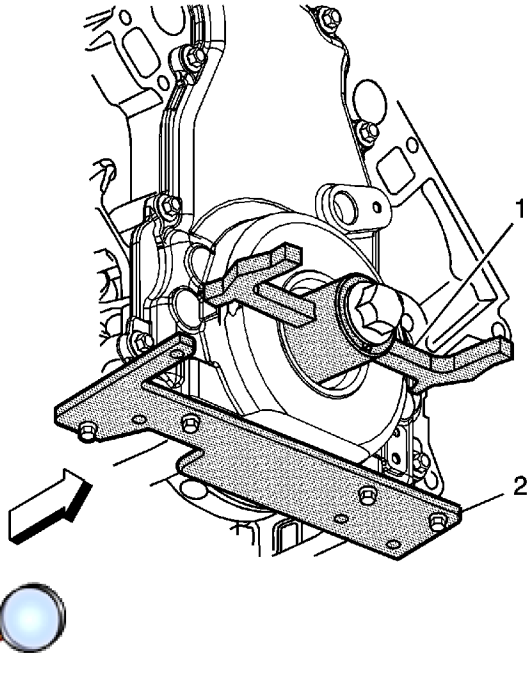


Note: Start the tool-to-front cover bolts. Do not tighten the bolts at this time.

4. Install the *J 41480* alignment tool . Tighten the tool-to-engine block bolts to **25 N·m (18 lb ft)**.

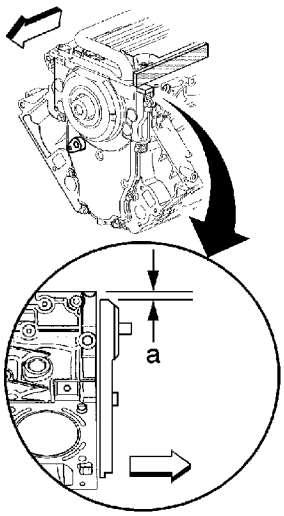


5. Install the *EN 48853-2* adapters as required for usage on the **141 mm (5.55 in)** dimension (a) front cover. Position the adapters against the legs of the *EN-48853* alignment tool with the words "cover side" (1) facing away from the tool.



Note: Align the tapered legs of the tool with the machined alignment surfaces on the front cover.

6. Install the *EN-48853* alignment tool (1).
7. Install the crankshaft balancer bolt.
   7.1. Tighten the crankshaft balancer bolt by hand until snug. Do not overtighten.
   7.2. Tighten the *J 41480* alignment tool (2).
   7.3. Tighten the engine front cover bolts to **25 N·m (18 lb ft)**.
8. Remove the tools.

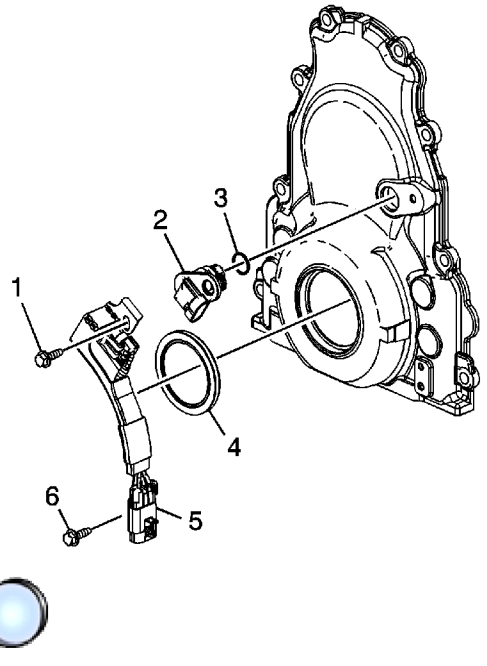


9. Measure the oil pan surface flatness, front cover-to-engine block.
   9.1. Place a straight edge across the engine block and front cover oil pan sealing surfaces.

Avoid contact with the portion of the gasket that protrudes into the oil pan surface.

9.2. Insert a feeler gage between the front cover and the straight edge tool. The cover must be flush with the oil pan surface, or no greater than **0.5 mm (0.02 in)** (a) below flush.

10. If the front cover-to-engine block oil pan surface alignment is not within specifications, repeat the cover alignment procedure.
11. If the correct front cover-to-engine block alignment cannot be obtained, replace the front cover.



12. Inspect the camshaft position (CMP) sensor O-ring seal (3) for cuts or damage. If the seal is not cut or damaged, it may be used again.
13. Lubricate the O-ring seal with clean engine oil.
14. Install the O-ring seal onto the sensor (2).
15. Install the sensor to the cover.
16. Install the CMP sensor wire harness (5) and bolts (1, 6). Tighten the bolts to **12 N·m (106 lb in)**.

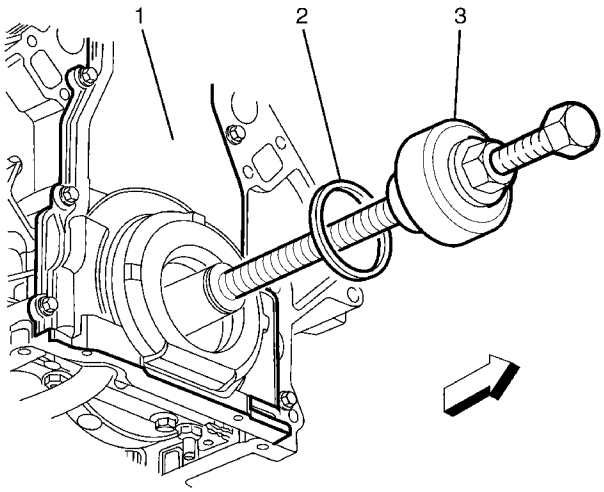
Crankshaft Front Oil Seal Installation

Tools Required

J 41478 Crankshaft Front Oil Seal Installer

Important:

- Do not lubricate the oil seal sealing surface.
- Do not reuse the crankshaft oil seal.
- Lubricate the outer edge of the oil seal with clean engine oil.
- Lubricate the front engine cover oil seal bore with clean engine oil.



1. Install the crankshaft front oil seal onto the J 41478 (3) guide.
2. Install the J 41478 (3) threaded rod (with nut, washer, guide, and oil seal) into the end of the crankshaft.
3. Use the J 41478 (3) in order to install the oil seal (2) into the front engine cover (1) bore.
   - 3.1. Use a wrench and hold the hex on the installer tool.
   - 3.2. Use a second wrench and rotate the installer nut clockwise until the seal bottoms in the front engine cover (1) bore.
   - 3.3. Remove the tool.
   - 3.4. Inspect the oil seal for correct installation. The oil seal should be installed evenly and completely into the front cover bore.

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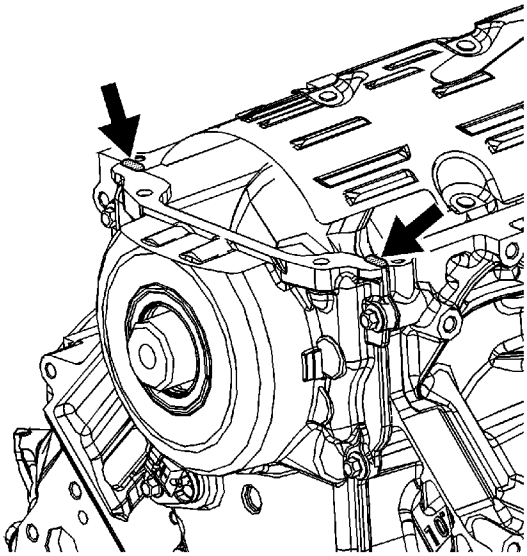
Oil Pan Installation



Note:

- The alignment of the structural oil pan is critical. The rear bolt hole locations of the oil pan provide mounting points for the transmission housing. To ensure the rigidity of the powertrain and correct transmission alignment, it is important that the rear of the block and the rear of the oil pan are flush, or even. The rear of the oil pan must NEVER protrude beyond the engine block and transmission housing plane.
- Do not use the oil pan gasket again.
- It is not necessary to rivet the NEW gasket to the oil pan.

1. Install the baffle, as required. Refer to Oil Pan Cleaning and Inspection.
2. Apply a **5 mm (0.2 in)** bead of sealant GM P/N 12378521 (Canadian P/N 88901148), or equivalent, **20 mm (0.8 in)** long to the engine block. Apply the sealant directly onto the tabs of the front cover gasket that protrude into the oil pan surface. Refer to Adhesives, Fluids, Lubricants, and Sealers.

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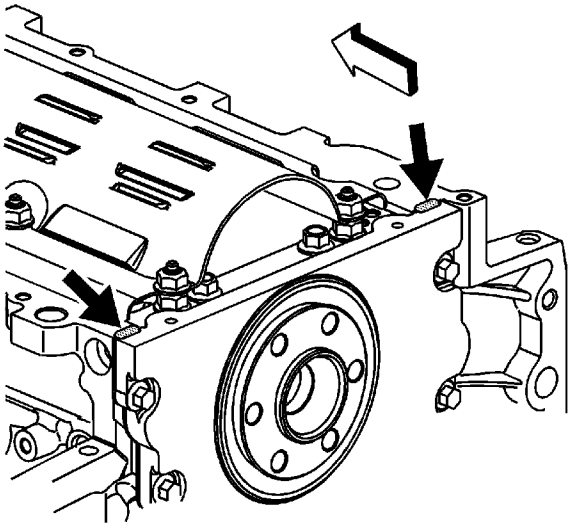
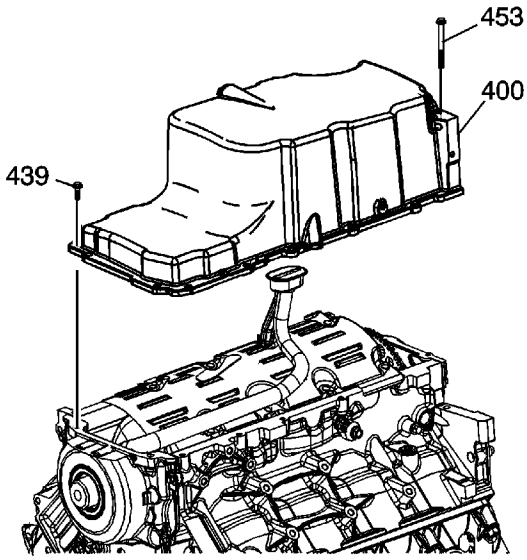
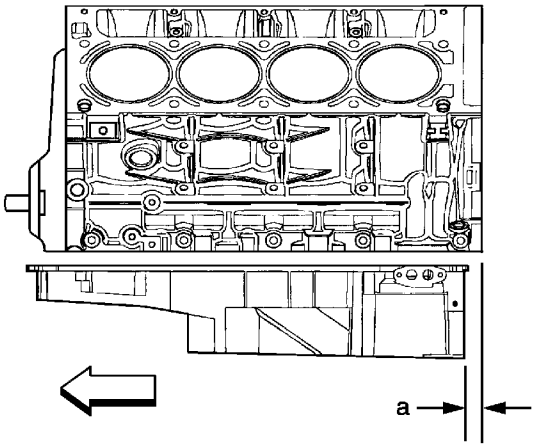


3. Apply a **5 mm (0.2 in)** bead of sealant GM P/N 12378521 (Canadian P/N 88901148), or equivalent, **20 mm (0.8 in)** long to the engine block. Apply the sealant directly onto the tabs of the rear housing gasket that protrude into the oil pan surface.



Note: Ensure the oil gallery passages in the oil pan and engine block properly align with the oil pan gasket.

4. Pre-assemble the oil pan gasket to the pan.
   4.1. Install the gasket onto the oil pan.
   4.2. Install the oil pan bolts to the pan and through the gasket.
5. Install the oil pan (400), gasket, and bolts (439 and 453) to the engine block.
6. Tighten the bolts finger tight. Do not overtighten.



7. Place a straight edge across the rear of the engine block and the rear of the oil pan at the transmission housing mounting surfaces.

Caution: Refer to Fastener Caution in the Preface section.

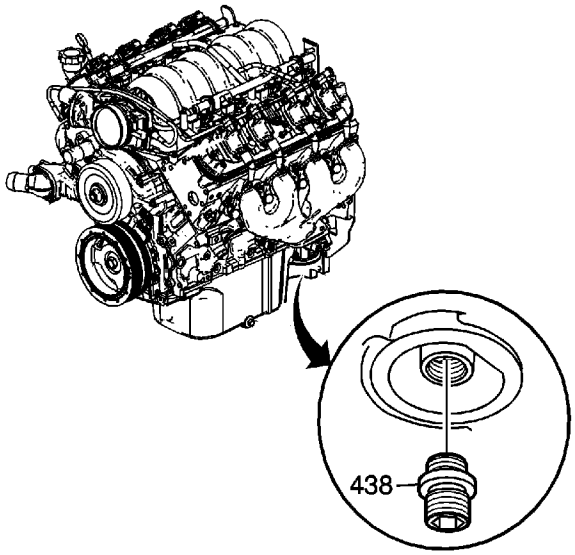
8. Align the oil pan until the rear of engine block and rear of oil pan are flush or even.
   8.1. Tighten the oil pan-to-block and oil pan-to-front cover bolts to **25 N·m (18 lb ft)**.
   8.2. Tighten the oil pan-to-rear housing bolts to **12 N·m (106 lb in)**.
9. Measure the oil pan-to-engine block alignment (a).
   9.1. Place a straight edge across the rear of the engine block and rear of oil pan at the transmission housing mounting surfaces.

Note: The rear of the oil pan must NEVER protrude beyond the engine block and transmission housing mounting surfaces.

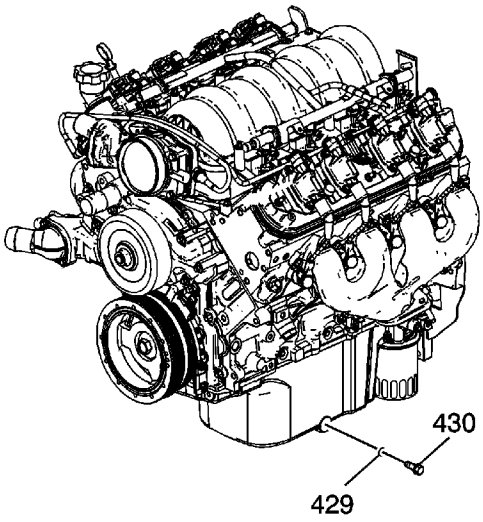
   9.2. Insert a feeler gage between the straight edge and the oil pan transmission housing mounting surface, and inspect to ensure there is no greater than a **0.1 mm (0.004 in)** gap (a) between the pan and straight edge.
   9.3. If the oil pan alignment is not within specifications, remove the oil pan and repeat the above procedure.

Oil Filter, Adapter, and Pan Cover Installation

Caution: Refer to Fastener Caution in the Preface section.



1. Install the oil filter fitting (438) and tighten to **55 N·m (40 lb ft)**.



2. Install the oil pan drain plug (430) and O-ring (429) and tighten to **25 N·m (18 lb ft)**.

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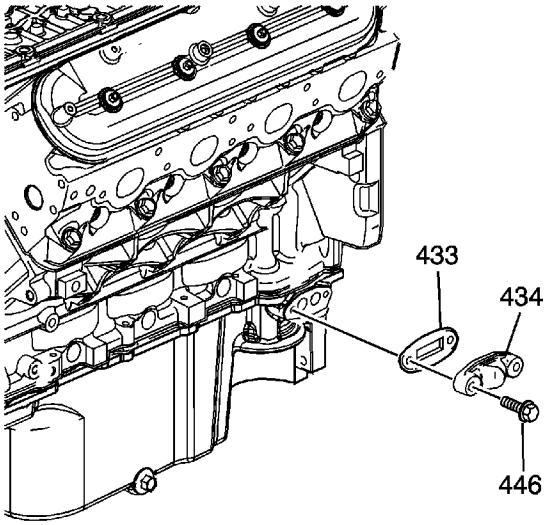
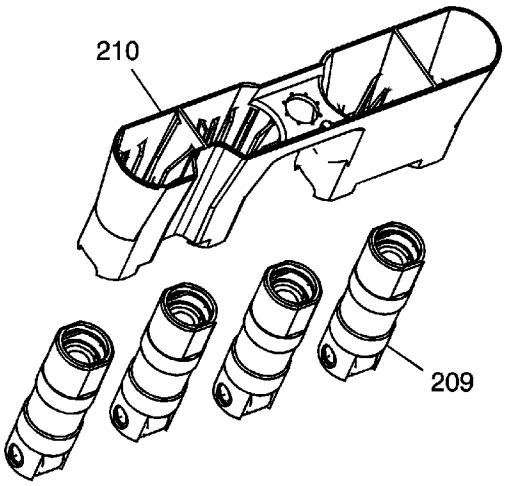


3. Install the gasket (433), cover (434), and bolts (446) and tighten to **12 N·m (106 lb ft)**.

Valve Lifter Installation



Note:

- When using the non-Active Fuel Management (AFM) valve lifters again, install the lifters to their original locations.
- If camshaft replacement is required, the valve lifters must also be replaced.

1. Lubricate the valve lifters (209) and engine block valve lifter bores with clean engine oil.
2. Insert the valve lifters into the lifter guides (210).

   Align the flat area on the top of the lifter with the flat area in the lifter guide bore. Push the lifter completely into the guide bore.

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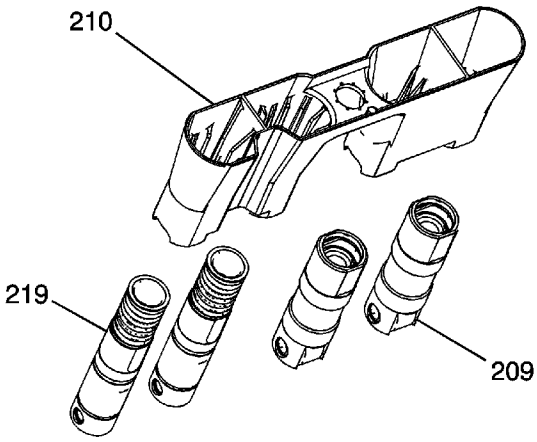
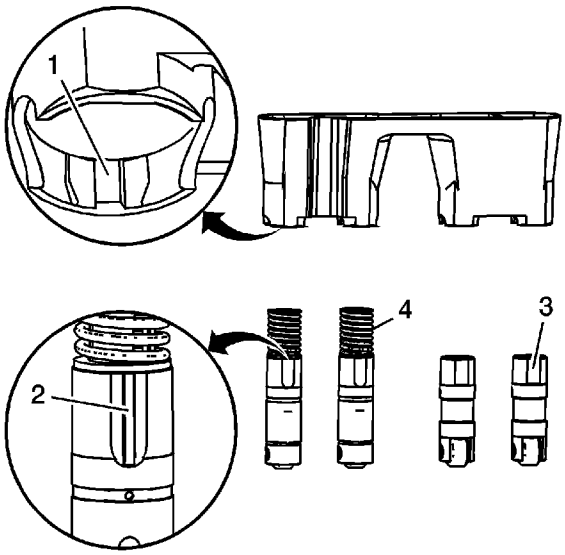


Note:

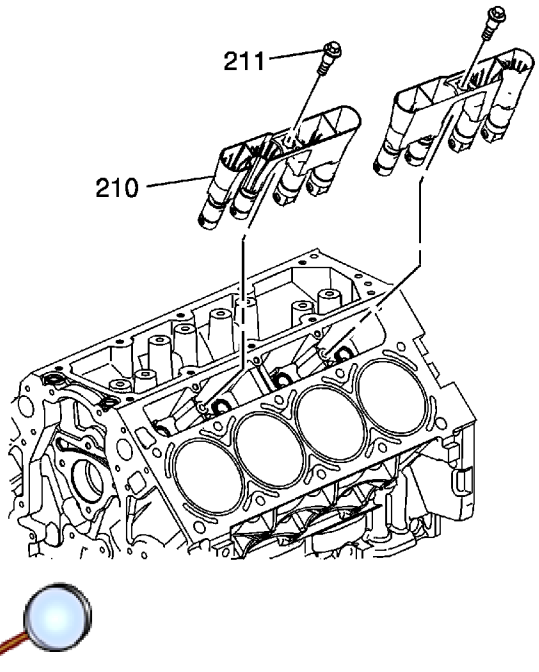
- When using the AFM valve lifters again, install the lifters to their original locations.
- If camshaft replacement is required, the valve lifters must also be replaced.
- Each of the 4 valve guide assemblies will contain 2 active fuel management valve lifters and 2 non-active fuel management valve lifters.
- With the lifters and guides properly installed, cylinders 1, 4, 6, and 7 lifter bores will each contain 2 active fuel management valve lifters.

3. Lubricate the valve lifters (209, 219) and engine block valve lifter bores with clean engine oil.



4. Insert the valve lifters into the lifter guides.

- Align the flat area (3) on the top of the non-active fuel management lifter with the flat area in the lifter guide bore. Push the lifter completely into the guide bore.
- The active fuel management lifters (4) are to be installed into the guide, with the notch in the guide (1) aligned with the raised area (2) of the lifter.



5. Install the valve lifters and guide assembly (210) to the engine block.

   Caution: Refer to Fastener Caution in the Preface section.

6. Install the valve lifter guide bolts (211) and tighten to **12 N·m (106 lb in)**.

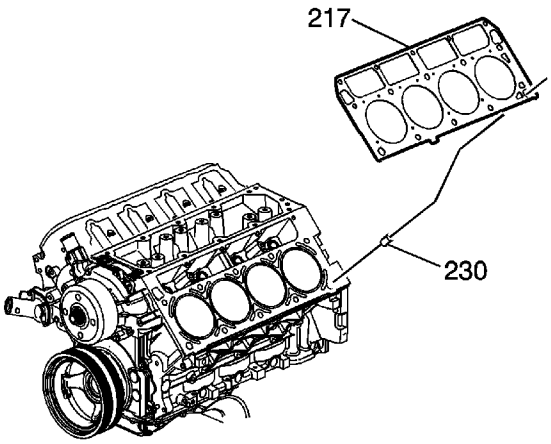
Cylinder Head Installation - Left Side

Special Tools

- *J 42385-100* Head/Main Bolt Thread Repair Kit
- *J 45059* Angle Meter

For equivalent regional tools, refer to Special Tools.

Warning: Refer to Safety Glasses Warning in the Preface section.



Caution: Clean all dirt, debris, and coolant from the engine block cylinder head bolt holes. Failure to remove all foreign material may result in damaged threads, improperly tightened fasteners or damage to components.

Note:

- Do not use the cylinder head bolts again. Install NEW cylinder head bolts during assembly.
- Do not use any type of sealant on the cylinder head gasket, unless specified.

1. Clean the engine block cylinder head bolt holes, if required.

   J 42385-107 thread repair tool may be used to clean the threads of old threadlocking material.

2. Spray cleaner GM P/N 12346139 (Canadian P/N 10953463), GM P/N 12377981

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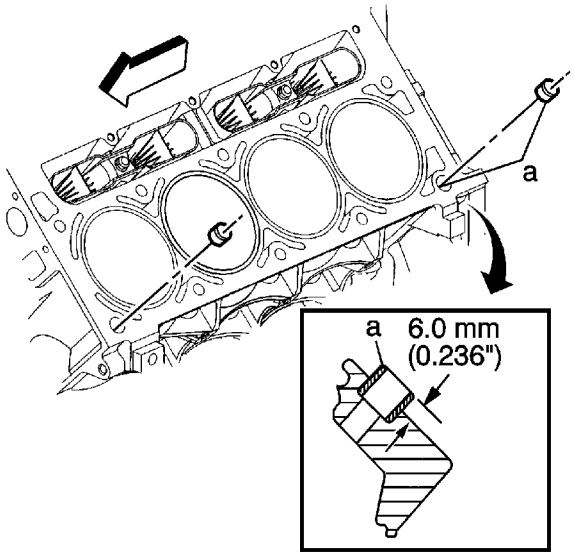
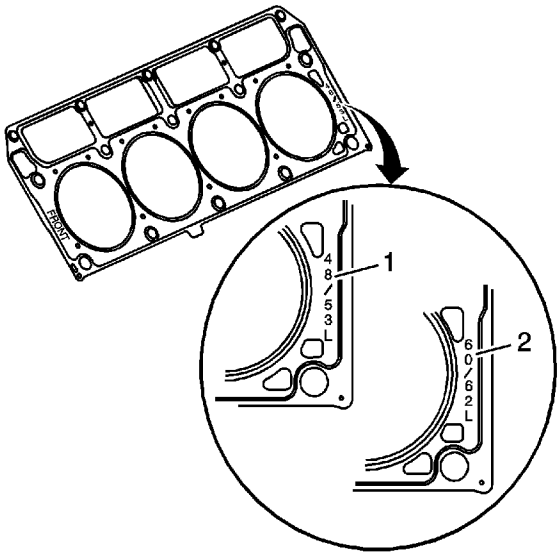
(Canadian P/N 10953463), or equivalent, into the hole.

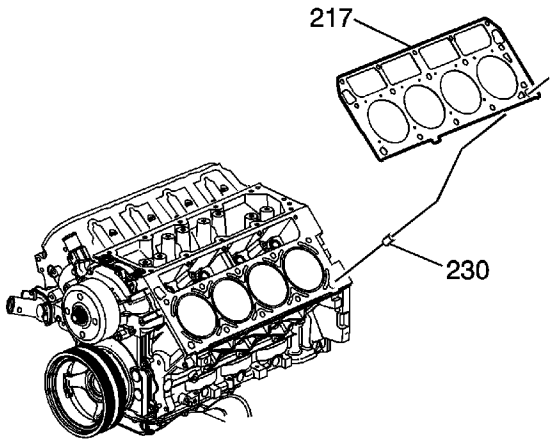
3. Clean the cylinder head bolt holes with compressed air.
4. Install the cylinder head locating pins (230).



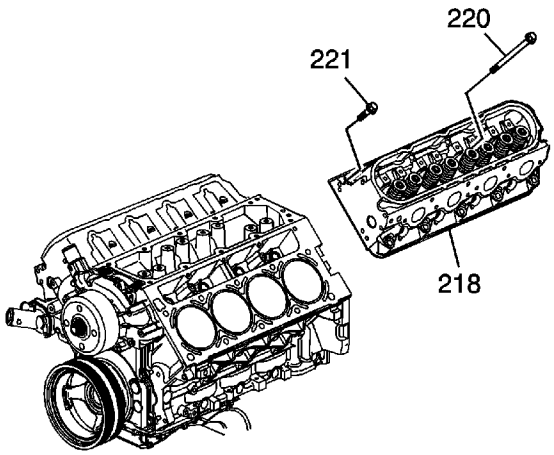
5. Inspect the locating pins for proper installation.



6. Inspect the displacement markings (1, 2) on the gasket, for proper usage.

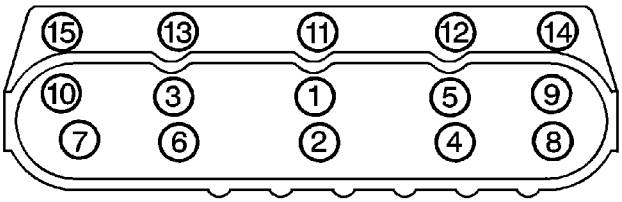


7. Install the NEW cylinder head gasket (217) onto the locating pins.



8. Install the cylinder head (218) onto the locating pins and the gasket.
9. Install the NEW cylinder head bolts (220, 221).

Caution: Refer to Fastener Caution in the Preface section.



10. Tighten the cylinder head bolts.
    10.1. Tighten the M11 cylinder head bolts (1-10) a first pass in sequence to **30 N·m (22 lb ft)**.
    10.2. Tighten the M11 cylinder head bolts (1-10) a second pass in sequence to **90 degrees** using the *J 45059* meter .
    10.3. Tighten the M11 cylinder head bolts (1-10) a final pass in sequence to **70 degrees** using the *J 45059* meter .
    10.4. Tighten the M8 cylinder head bolts (11-15) to **30 N·m (22 lb ft)**. Begin with the center bolt (11) and alternating side-to-side, work outward tightening all of the bolts.

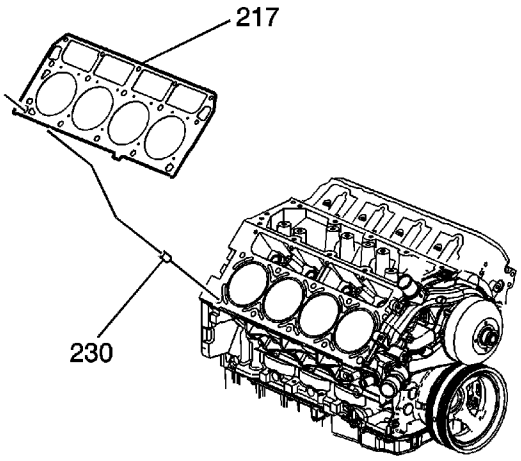
Cylinder Head Installation - Right Side

Special Tools

- *J 42385-100* Head/Main Bolt Thread Repair Kit
- *J 45059* Angle Meter

For equivalent regional tools, refer to Special Tools.

Warning: Refer to Safety Glasses Warning in the Preface section.



Caution: Clean all dirt, debris, and coolant from the engine block cylinder head bolt holes. Failure to remove all foreign material may result in damaged threads, improperly tightened fasteners or damage to components.

Note:

- Do not use the cylinder head bolts again. Install NEW cylinder head bolts during assembly.
- Do not use any type of sealant on the cylinder head gasket, unless specified.

1. Clean the engine block cylinder head bolt holes, if required.

   J 42385-107 thread repair tool may be used to clean the threads of old threadlocking material.

2. Spray cleaner GM P/N 12346139 (Canadian P/N 10953463), GM P/N 12377981

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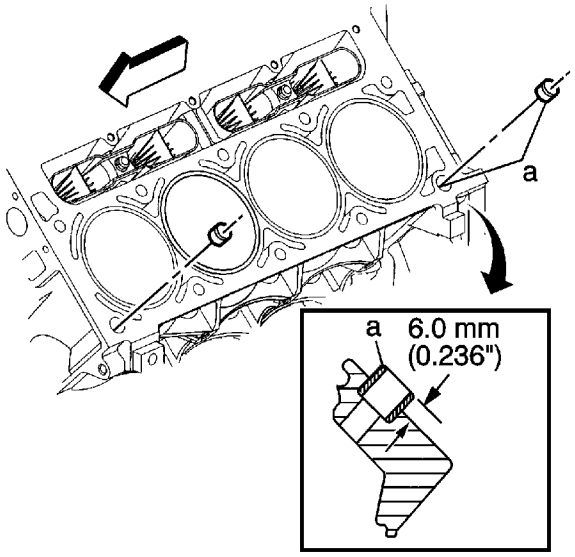
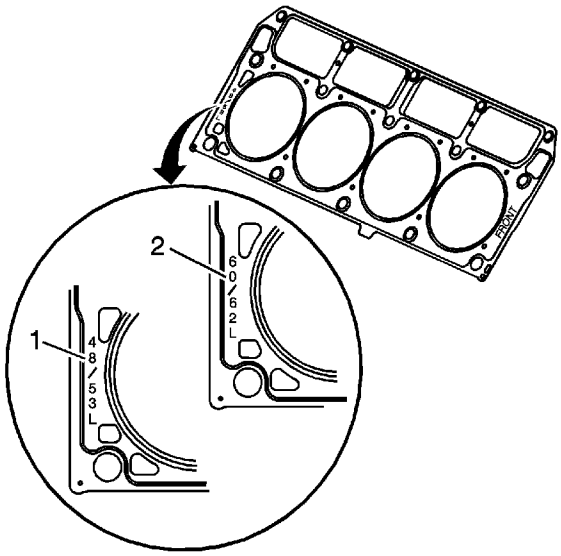
(Canadian P/N 10953463), or equivalent, into the hole.

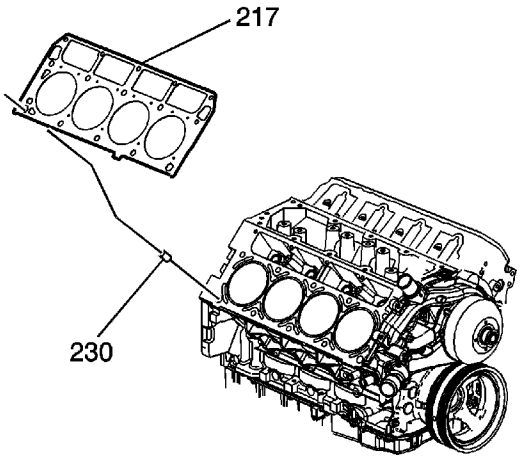
3. Clean the cylinder head bolt holes with compressed air.
4. Install the cylinder head locating pins (230).



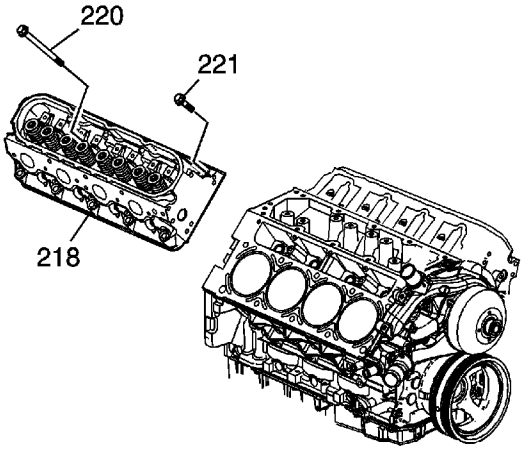
5. Inspect the locating pins for proper installation.



6. Inspect the displacement markings (1, 2) on the gasket, for proper usage.

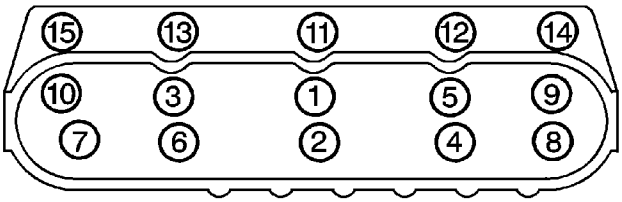


7. Install the NEW cylinder head gasket (217) onto the locating pins.



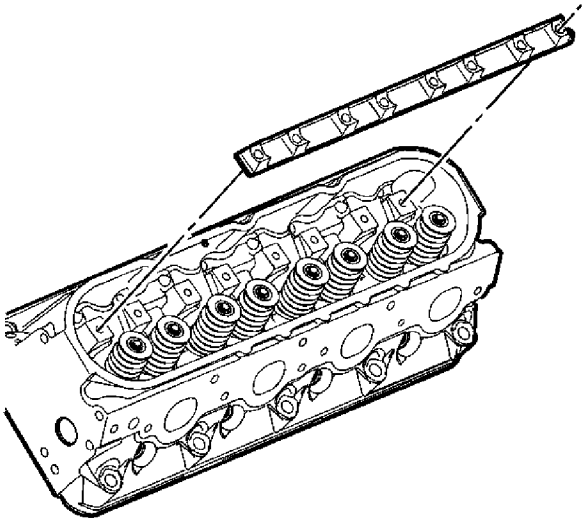
8. Install the cylinder head (218) onto the locating pins and the gasket.
9. Install the NEW cylinder head bolts (220, 221).

Caution: Refer to Fastener Caution in the Preface section.



10. Tighten the cylinder head bolts.
    10.1. Tighten the M11 cylinder head bolts (1-10) a first pass in sequence to **30 N·m (22 lb ft)**.
    10.2. Tighten the M11 cylinder head bolts (1-10) a second pass in sequence to **90 degrees** using the *J 45059* meter .
    10.3. Tighten the M11 cylinder head bolts (1-10) a final pass in sequence to **70 degrees** using the *J 45059* meter .
    10.4. Tighten the M8 cylinder head bolts (11-15) to **30 N·m (22 lb ft)**. Begin with the center bolt (11) and alternating side-to-side, work outward tightening all of the bolts.

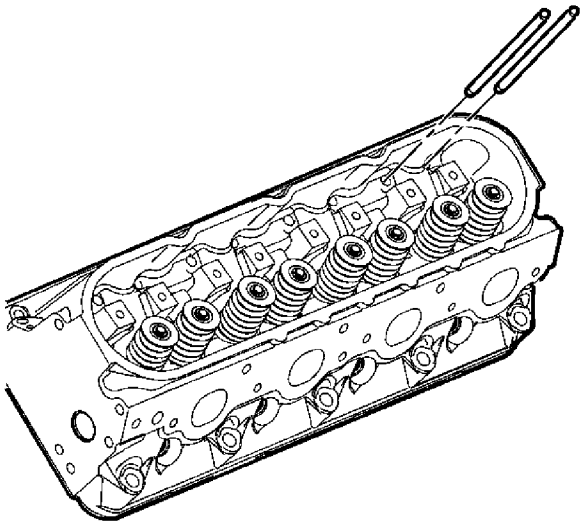
Valve Rocker Arm and Push Rod Installation



Note:

- When using the valve train components again, always install the components to the original location and position.
- Valve lash is net build. No valve adjustment is required.

1. Lubricate the valve rocker arms and pushrods with clean engine oil.
2. Lubricate the flange of the valve rocker arm bolts with clean engine oil.
3. Install the valve rocker arm pivot support.



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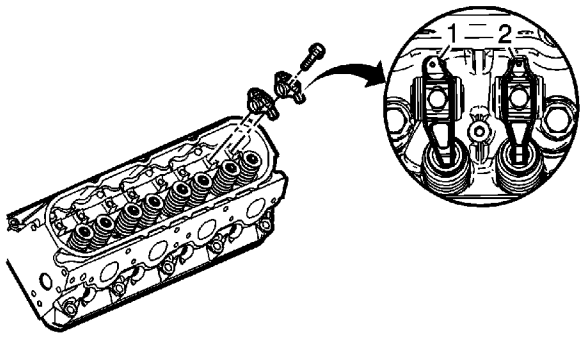
Note: Ensure the pushrods seat properly to the valve lifter sockets.

4. Install the pushrods.

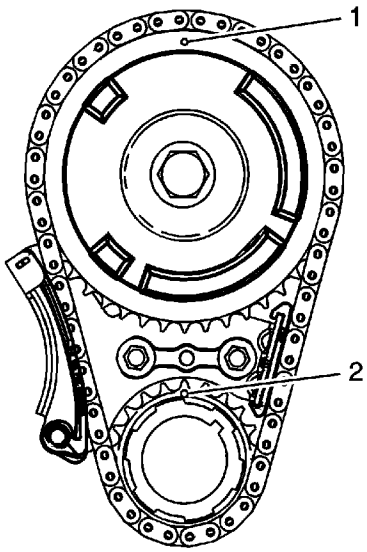


Note:

- Ensure the pushrods seat properly to the ends of the rocker arms.
- DO NOT tighten the rocker arm bolts at this time.

5. Install the rocker arms and bolts.

The intake rocker arms (1) have an offset design.



6. Rotate the crankshaft until number 1 piston is at top dead center of compression stroke.

   In this position, cylinder number 1 rocker arms will be off lobe lift, and the crankshaft sprocket key will be at the 1:30 position. The camshaft and crankshaft sprocket alignment marks (1, 2) will be in the 12 o'clock position. If viewing from the rear of the engine, the additional crankshaft pilot hole, non-threaded, will be in the 10:30 position.

   The engine firing order is 1, 8, 7, 2, 6, 5, 4, 3.

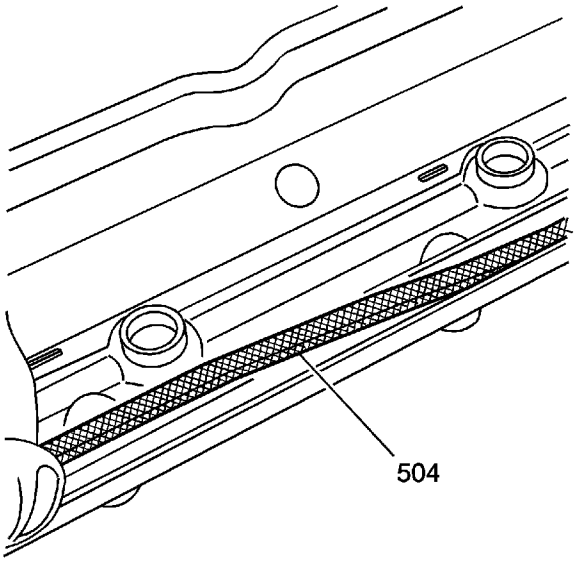
   Cylinders 1, 3, 5 and 7 are left bank.

   Cylinders 2, 4, 6, and 8 are right bank.

   Caution: Refer to Fastener Caution in the Preface section.

7. With the engine in the number 1 firing position, tighten the following valve rocker arm bolts:
   7.1. Tighten the exhaust valve rocker arm bolts 1, 2, 7, and 8 to **30 N·m (22 lb ft)**.
   7.2. Tighten the intake valve rocker arm bolts 1, 3, 4, and 5 to **30 N·m (22 lb ft)**.
8. Rotate the crankshaft 360 degrees.
9. Tighten the following valve rocker arm bolts:
   9.1. Tighten the exhaust valve rocker arm bolts 3, 4, 5, and 6 to **30 N·m (22 lb ft)**.
   9.2. Tighten the intake valve rocker arm bolts 2, 6, 7, and 8 to **30 N·m (22 lb ft)**.

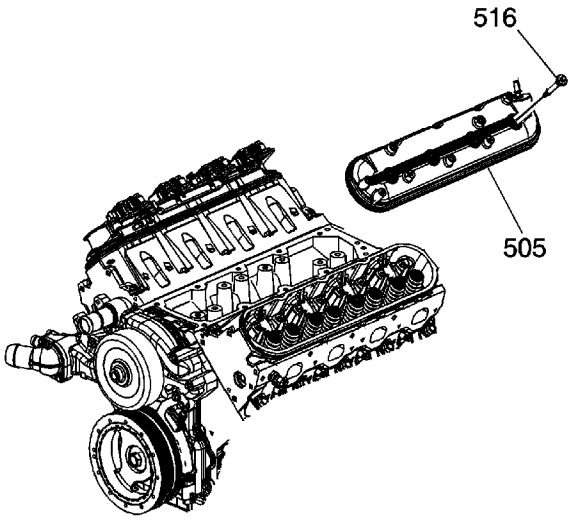
Valve Rocker Arm Cover Installation - Left Side



Note:

- All gasket surfaces should be free of oil or other foreign material during assembly.
- DO NOT use the valve rocker arm cover gasket again.

1. Install NEW valve rocker arm cover grommets and use NEW valve rocker arm cover bolts if they are serviced with the grommet.
2. Install a NEW gasket (504) into the valve rocker arm cover.



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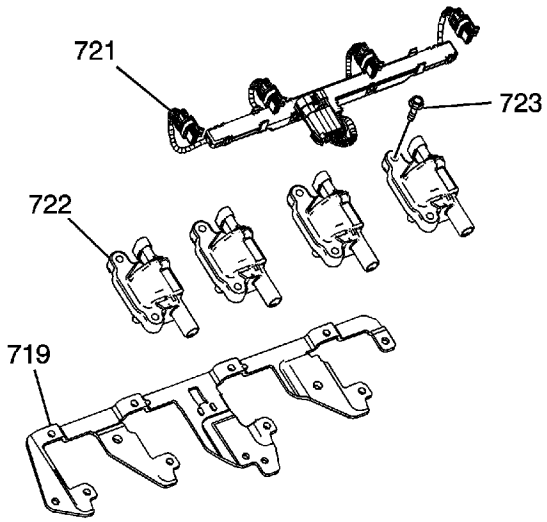
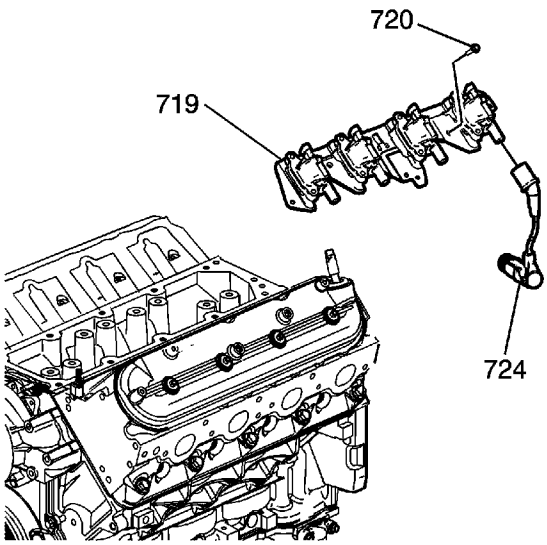
3. Install the valve rocker arm cover (505) onto the cylinder head.

   Caution: Refer to Fastener Caution in the Preface section.

4. Install the cover bolts (516) with grommets and tighten to **12 N·m (106 lb in)**.



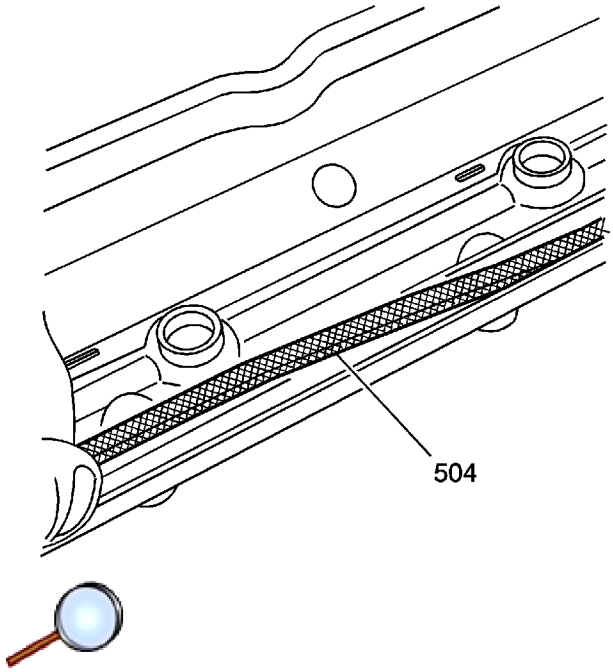
5. Apply threadlock GM P/N 12345382 (Canadian P/N 10953489), or equivalent, to the threads of the ignition coil bolts (723).
6. Install the ignition coils (722), wire harness (721), and bolts (723) to the bracket (719) and tighten to **10 N·m (89 lb in)**.



7. Apply threadlock GM P/N 12345382 (Canadian P/N 10953489), or equivalent, to the threads of the ignition coil bracket studs (720).

8. Install the ignition coil and bracket assembly (719) and studs (720) and tighten to **12 N·m (106 lb in)**.

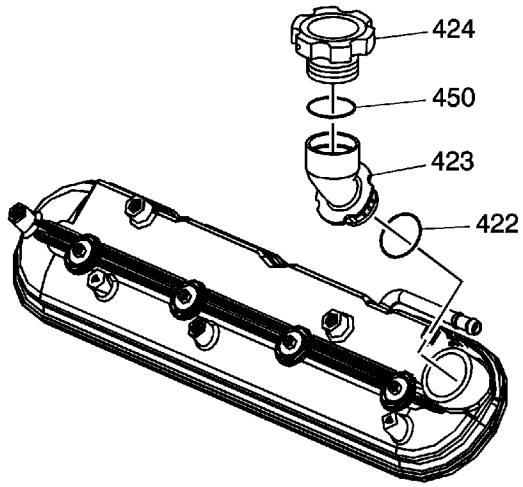
Valve Rocker Arm Cover Installation - Right Side



Note:

- All gasket surfaces should be free of oil or other foreign material during assembly.
- DO NOT use the valve rocker arm cover gasket again.

1. Install NEW valve rocker arm cover grommets and use NEW valve rocker arm cover bolts if they are serviced with the grommet.
2. Install a NEW gasket (504) into the valve rocker arm cover.



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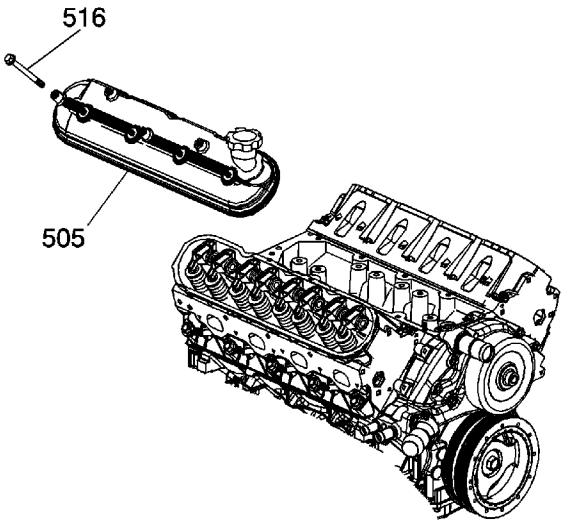
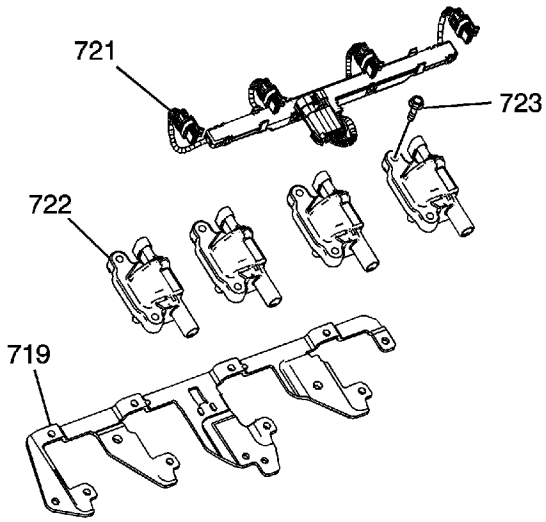
3. Install a NEW oil fill tube (423) and seal (422) to the valve rocker arm cover.



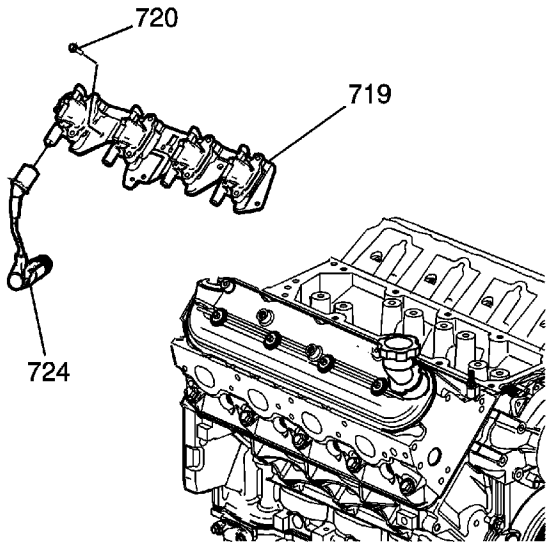
4. Install the valve rocker arm cover (505) onto the cylinder head.

Caution: Refer to Fastener Caution in the Preface section.

5. Install the cover bolts (516) with grommets and tighten to **12 N·m (106 lb in)**.

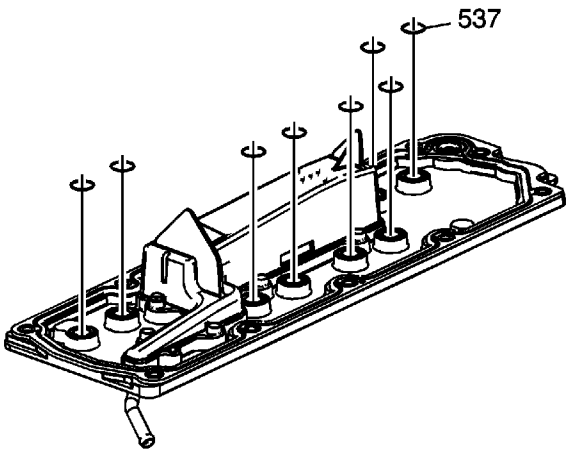


6. Apply threadlock GM P/N 12345382 (Canadian P/N 10953489), or equivalent, to the threads of the ignition coil bolts (723).
7. Install the ignition coils (722), wire harness (721), and bolts (723) to the bracket (719). Tighten the ignition coil bolts to **10 N·m (89 lb in)**.



8. Apply threadlock GM P/N 12345382 (Canadian P/N 10953489), or equivalent, to the threads of the ignition coil bracket studs (720).
9. Install the ignition coil and bracket assembly (719) and studs (720). Tighten the bracket studs to **12 N·m (106 lb in)**.

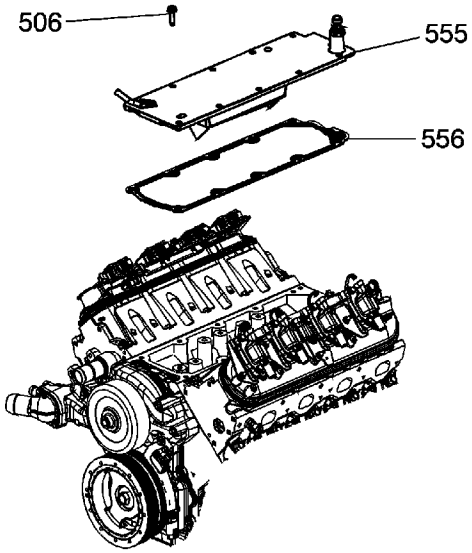
Engine Block Valley Cover Installation



Note: All gasket surfaces should be free of oil or other foreign material during assembly.

1. Lubricate the O-ring seals (537) with clean engine oil.
2. Install the O-ring seals (537) to the cover.

Caution: Refer to Fastener Caution in the Preface section.



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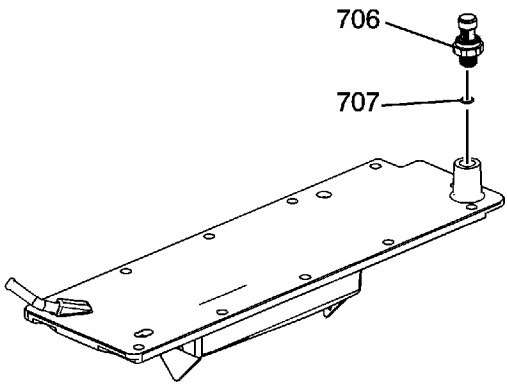
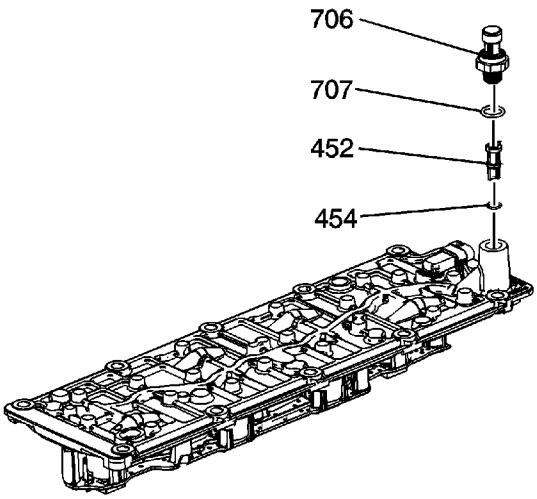
3. Install the cover (555), gasket (556), and bolts (506). Tighten the cover bolts to **25 N·m (18 lb ft)**.



4. Apply sealant GM P/N 12346004 (Canadian P/N 10953480), or equivalent, to the threads of the sensor.
5. Install the oil pressure sensor (706) and sealing washer (707). Tighten the sensor to **35 N·m (26 lb ft)**.

Valve Lifter Oil Filter Installation



Note: Do not allow dirt or debris to enter the oil passages of the manifold. Plug, as required.

1. Install a NEW oil filter (452) and O-ring (454) assembly.
2. Apply sealant GM P/N 12346004 (Canadian P/N 10953480) to the threads of the sensor.

Caution: Refer to Fastener Caution in the Preface section.

3. Install the oil pressure sensor (706) and washer (707). Tighten the oil pressure sensor to **35 N·m (26 lb ft)**.

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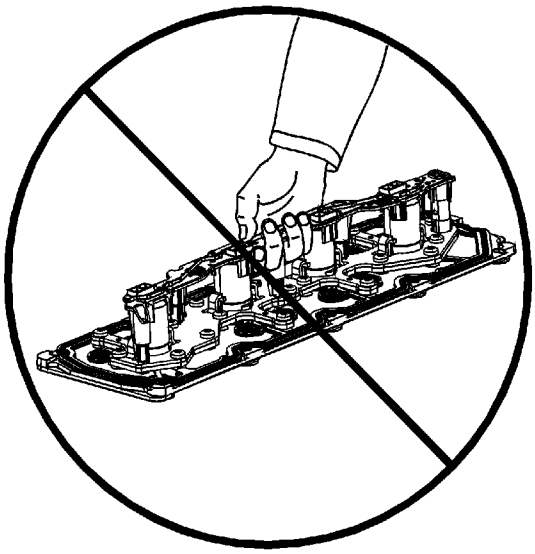
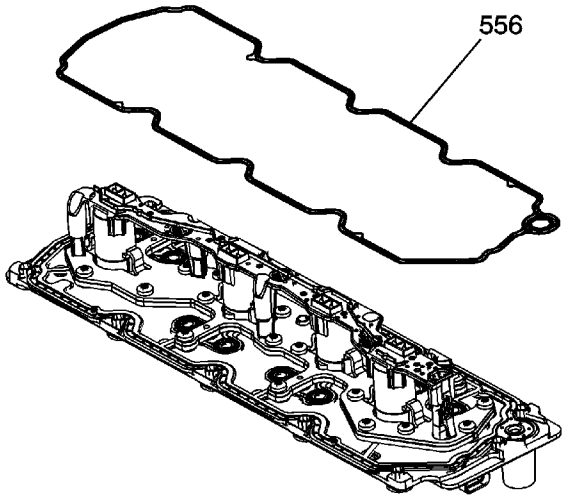
Valve Lifter Oil Manifold Installation



1. Do not lift the manifold assembly by the electrical lead frame.



Note:

- All gasket surfaces should be free of oil or other foreign material during assembly.
- Do not allow dirt or debris to enter the manifold. Plug as required.

2. Install the service gasket (556) onto the manifold.

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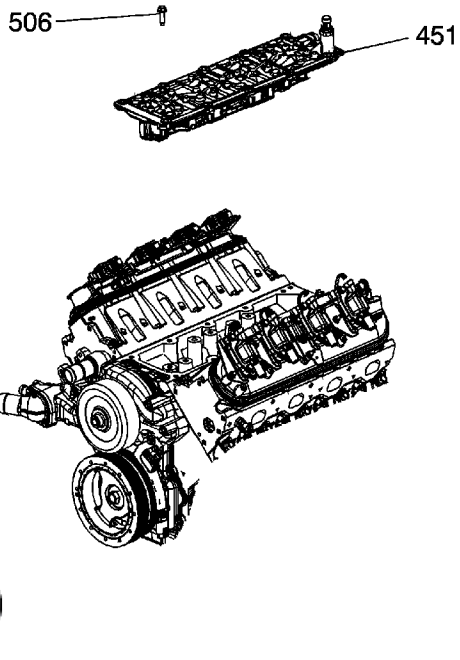
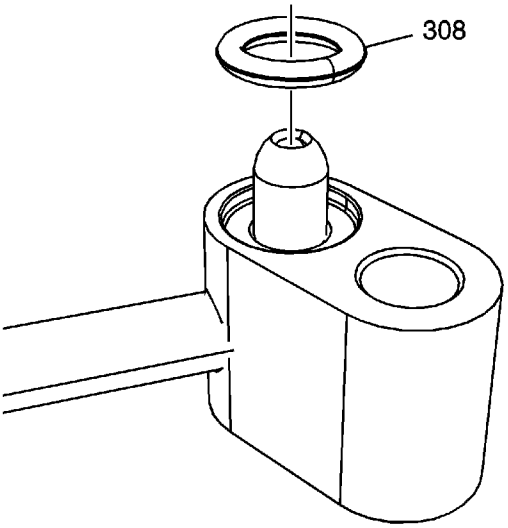


3. Install the manifold (451) with gasket.

   Caution: Refer to Fastener Caution in the Preface section.

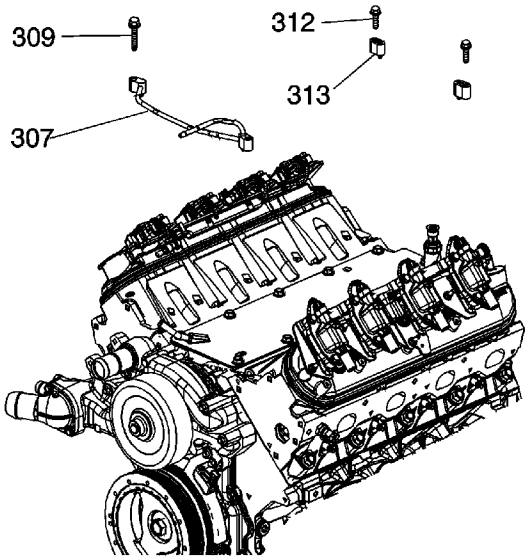
4. Install the manifold bolts (506) and tighten to **25 N·m (18 lb ft)**.

Engine Coolant Air Bleed Pipe and Hole Cover Installation



Note: Position the O-ring seal (308) onto the nipple portion of the pipe.

1. Install the seals onto the engine coolant air bleed pipe and covers.



2. Install the pipe (307) and seals (308).

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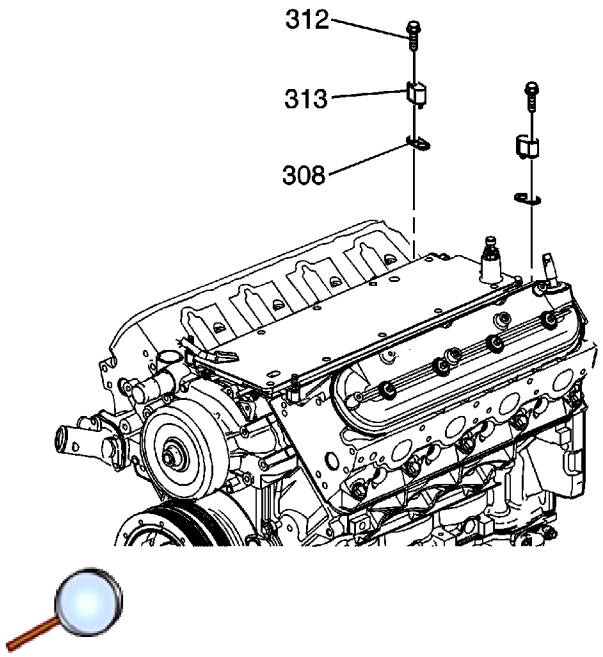
Caution: Refer to Fastener Caution in the Preface section.

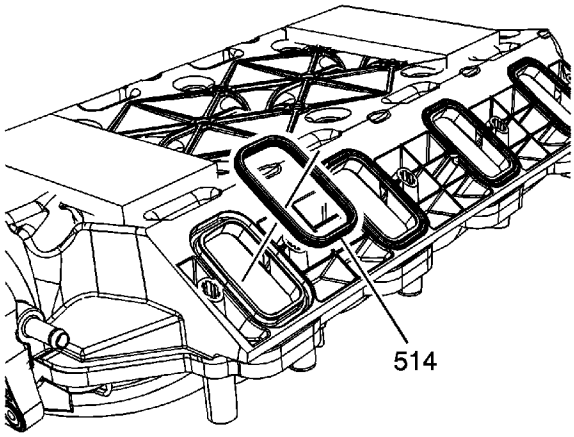
3. Install the bolts (309) and tighten to **12 N·m (106 lb in)**.



Note: Production engines use a rivet-type plug at the top rear coolant passage of each cylinder head. If service of a leaking plug is required, it is necessary to remove the cylinder head from the engine to properly remove the plug prior to cover installation.

4. Install the covers (313) and seals (308).
5. Install the bolts (312) and tighten to **12 N·m (106 lb in)**.

Intake Manifold Installation



Note:

- The intake manifold, throttle body, fuel injection rail, and fuel injectors may be removed as an assembly. If not servicing the individual components, install the intake manifold as a complete assembly.
- DO NOT use the intake manifold gaskets again. Install NEW intake manifold-to-cylinder head gaskets.

1. Install NEW intake manifold-to-cylinder head gaskets (514).

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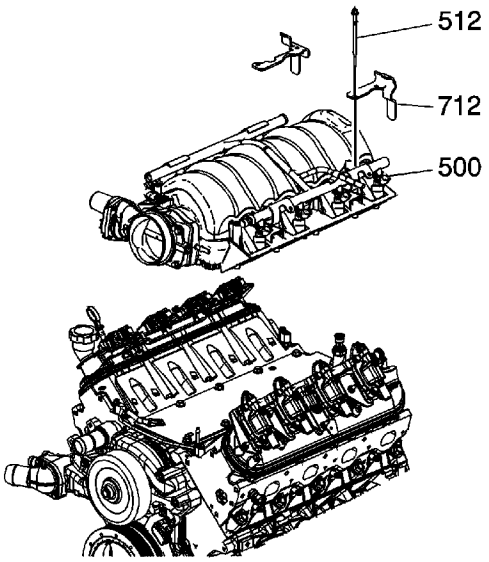
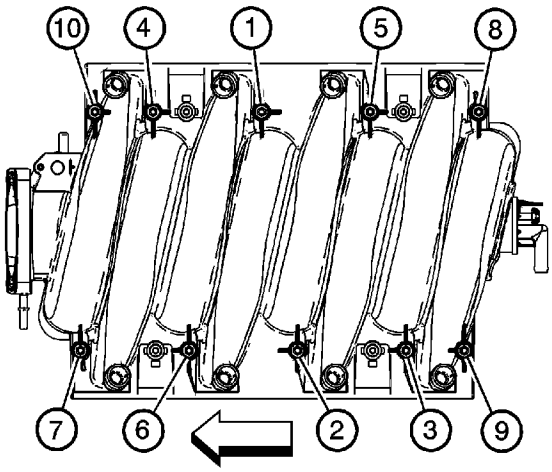
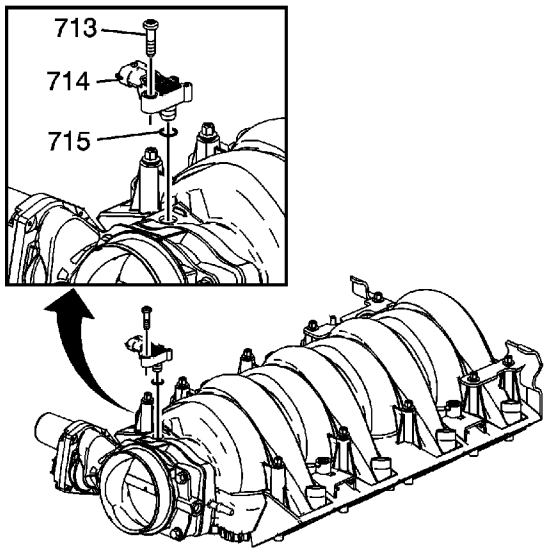


2. Install the intake manifold (500).
3. Apply a **5 mm (0.20 in)** band of threadlock GM P/N 12345382 (Canadian P/N 10953489) to the threads of the intake manifold bolts (512). Refer to Adhesives, Fluids, Lubricants, and Sealers.
4. Install the intake manifold bolts (512) and fuel rail stop brackets (712).

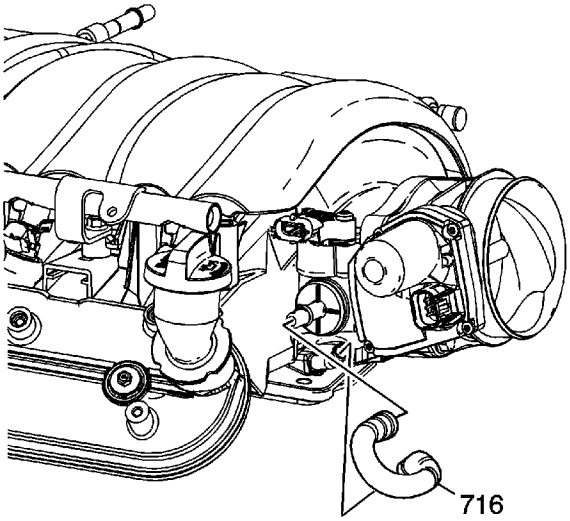
Caution: Refer to Fastener Caution in the Preface section.



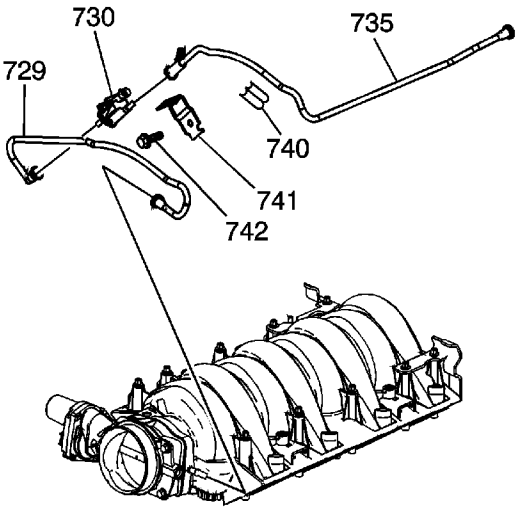
5. Tighten the intake manifold bolts.
   5.1. Tighten the intake manifold bolts (1-10) a first pass in sequence to **5 N·m (44 lb in)**.
   5.2. Tighten the intake manifold bolts (1-10) a final pass in sequence to **10 N·m (89 lb in)**.



6. Lubricate the manifold absolute pressure (MAP) sensor grommet (715) with clean engine oil.
7. Install the MAP sensor (714) and grommet (715).
8. Install the MAP sensor bolt (713).



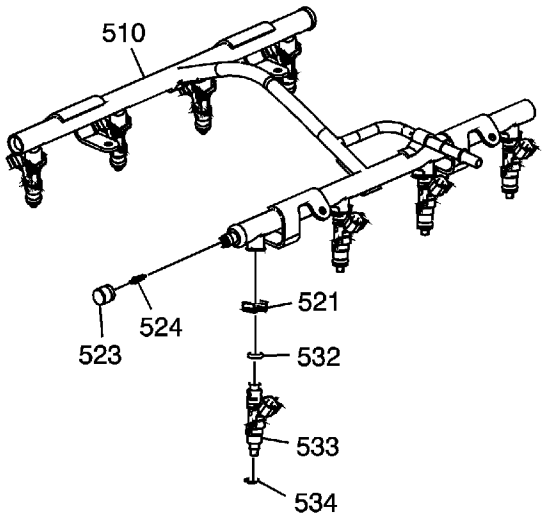
9. Install the positive crankcase ventilation (PCV) - dirty air hose (716).
10. Install the PCV - fresh air hose.



11. Install the evaporative emission (EVAP) canister purge solenoid valve (730), bracket (741), and bolt (742). Tighten the bolt to **50 N·m (37 lb ft)**.
12. Install the EVAP tubes (729 and 735).
13. Install the fuel rail. Refer to Fuel Rail and Injectors Installation.

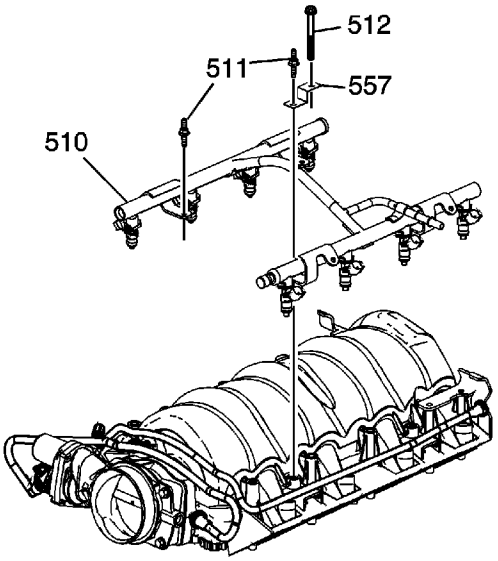
Fuel Rail and Injectors Installation

Warning: Refer to Fuel Rail Stop Bracket Installation Warning in the Preface section.



Note: DO NOT use the fuel injector O-ring seals again. Install NEW fuel injector O-ring seals during assembly.

1. Lubricate the NEW fuel injector O-ring seals (532 and 534) with clean engine oil.
2. Install the O-ring seals to the fuel injectors.
3. Install the fuel injectors (533) and retainers (521).



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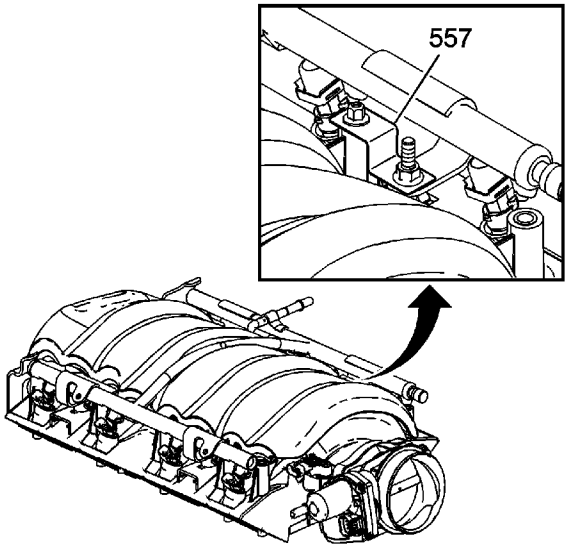
4. Install the fuel rail assembly (510) to the manifold. Push firmly on both sides of the rail until all injectors have entered their bores.
5. Apply a **5 mm (0.2 in)** band of threadlock GM P/N 12345382 (Canadian P/N 10953489), or equivalent, to the threads of the fuel rail bolts. Refer to Adhesives, Fluids, Lubricants, and Sealers.

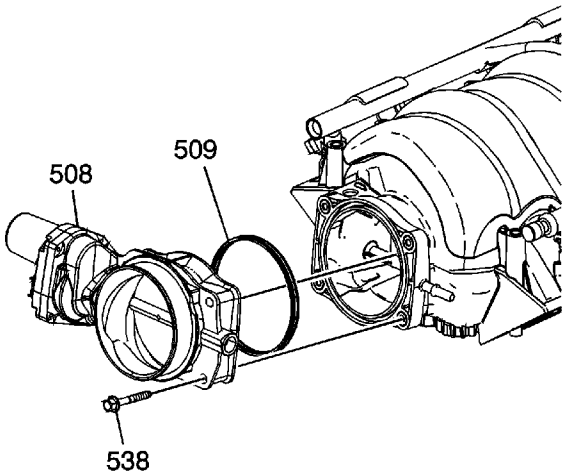
   Caution: Refer to Fastener Caution in the Preface section.

6. Install the fuel rail bolts (511 and 512) and fuel rail ground strap (557). Tighten the fuel rail bolts to **10 N·m (89 lb in)**.



7. Inspect the fuel rail ground strap (557) for proper installation.

Throttle Body Installation



Note: DO NOT use the throttle body gasket again. Install a NEW gasket during assembly.

1. Install the throttle body gasket (509) to the intake manifold. Align the locating tab of the gasket with the notch in the manifold.

   Caution: Refer to Fastener Caution in the Preface section.

2. Install the throttle body (508) and bolts (538). Tighten the throttle body bolts to **10 N·m (89 lb in)**.

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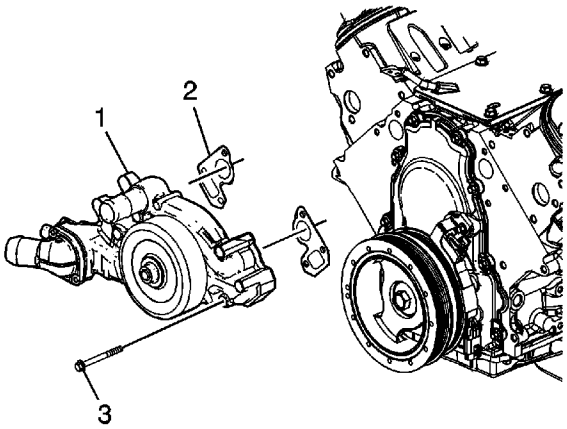
Water Pump Installation



Caution: DO NOT use cooling system seal tabs, or similar compounds, unless otherwise instructed. The use of cooling system seal tabs, or similar compounds, may restrict coolant flow through the passages of the cooling system or the engine components. Restricted coolant flow may cause engine overheating and/or damage to the cooling system or the engine components/assembly.

Note: All gasket surfaces are to be free of oil or other foreign material during assembly.

1. Install the water pump (1) and NEW gaskets (2).

   Caution: Refer to Fastener Caution in the Preface section.

2. Install the water pump bolts (3).
   2.1. Tighten the water pump bolts a first pass to **15 N·m (11 lb ft)**.
   2.2. Tighten the water pump bolts a final pass to **30 N·m (22 lb ft)**.

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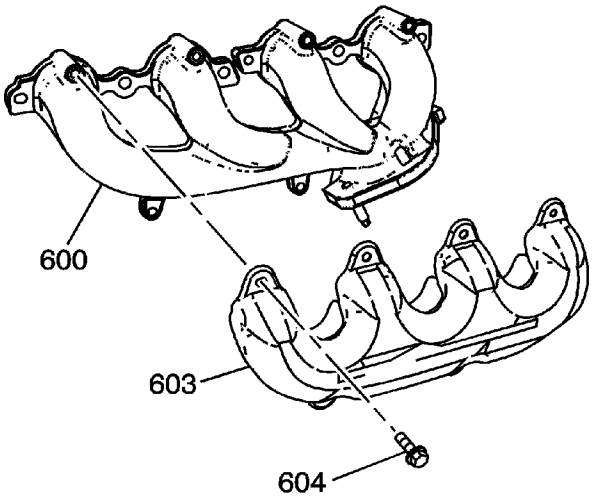
Exhaust Manifold Installation - Left Side

Caution: Refer to Fastener Caution in the Preface section.



Note:

- Tighten the exhaust manifold bolts as specified in the service procedure. Improperly installed and/or leaking exhaust manifold gaskets may affect vehicle emissions and/or on-board diagnostic (OBD) II system performance.
- The cylinder head exhaust manifold bolt hole threads must be clean and free of debris or threadlocking material.
- Do not apply sealant to the first 3 threads of the bolt.

1. Install the heat shield (603) and bolts (604) and tighten to **9 N·m (80 lb in)**.
2. Install the exhaust pipe studs and tighten to **20 N·m (15 lb ft)**.

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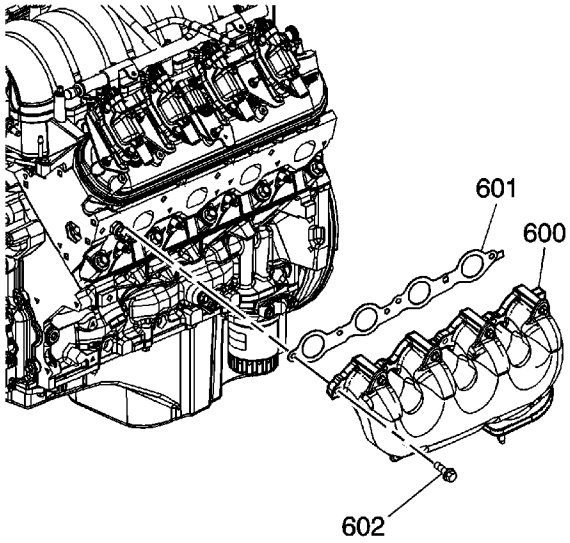
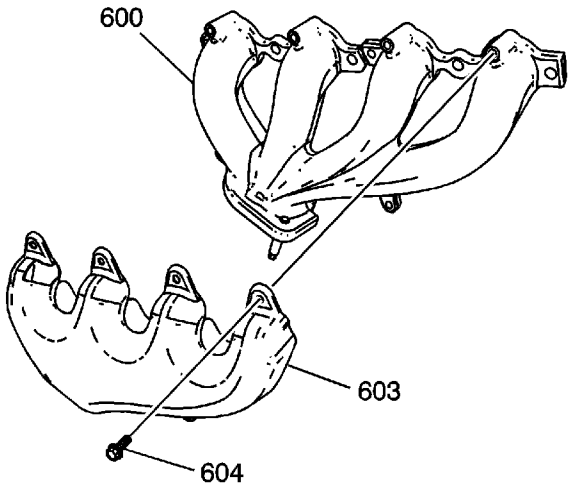


3. Apply a **5 mm (0.2 in)** wide band of threadlock GM P/N 12345493 (Canadian P/N 10953488), or equivalent, to the threads of the exhaust manifold bolts (602). Refer to Adhesives, Fluids, Lubricants, and Sealers.
4. Install the exhaust manifold (600), NEW gasket (601), and bolts.
   4.1. Tighten the exhaust manifold bolts a first pass to **15 N·m (11 lb ft)**. Tighten the exhaust manifold bolts beginning with the center 2 bolts. Alternate from side-to-side, and work toward the outside bolts.
   4.2. Tighten the exhaust manifold bolts a final pass to **20 N·m (15 lb ft)**. Tighten the exhaust manifold bolts beginning with the center 2 bolts. Alternate from side-to-side, and work toward the outside bolts.
5. Using a flat punch, bend over the exposed edge of the exhaust manifold gasket at the rear of the left cylinder head.

Exhaust Manifold Installation - Right Side

Caution: Refer to Fastener Caution in the Preface section.



Note:

- Tighten the exhaust manifold bolts as specified in the service procedure. Improperly installed and/or leaking exhaust manifold gaskets may affect vehicle emissions and/or on-board diagnostic (OBD) II system performance.
- The cylinder head exhaust manifold bolt hole threads must be clean and free of debris or threadlocking material.
- Do not apply sealant to the first 3 threads of the bolt.

1. Install the heat shield (603) and bolts (604) and tighten to **9 N·m (80 lb in)**.
2. Install the exhaust pipe studs and tighten to **20 N·m (15 lb ft)**.

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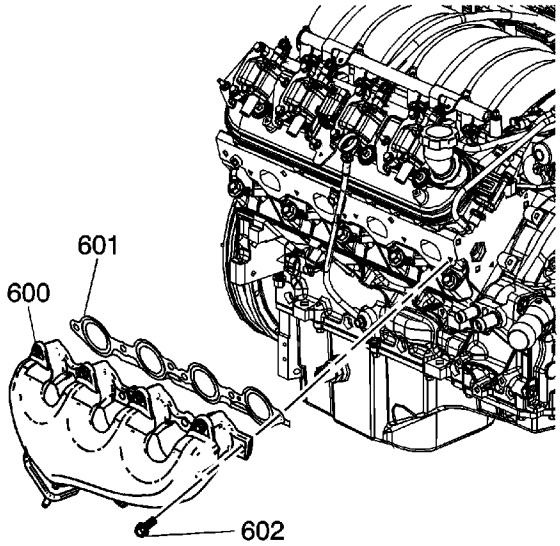
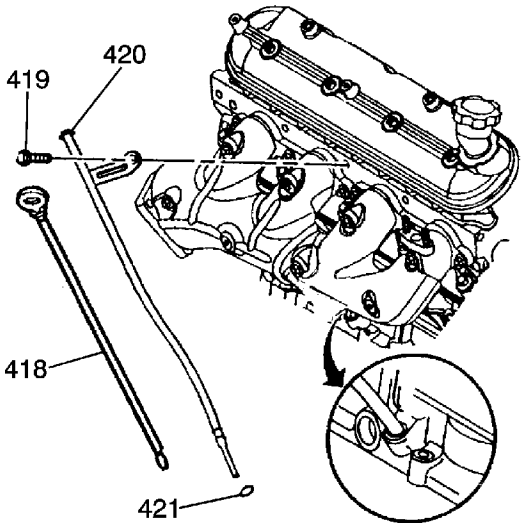


3. Apply a **5 mm (0.2 in)** wide band of threadlock GM P/N 12345493 (Canadian P/N 10953488), or equivalent, to the threads of the exhaust manifold bolts (602). Refer to Adhesives, Fluids, Lubricants, and Sealers.
4. Install the exhaust manifold (600), NEW gasket (601), and bolts.
   4.1. Tighten the exhaust manifold bolts a first pass to **15 N·m (11 lb ft)**. Tighten the exhaust manifold bolts beginning with the center 2 bolts. Alternate from side-to-side, and work toward the outside bolts.
   4.2. Tighten the exhaust manifold bolts a final pass to **20 N·m (15 lb ft)**. Tighten the exhaust manifold bolts beginning with the center 2 bolts. Alternate from side-to-side, and work toward the outside bolts.
5. Using a flat punch, bend over the exposed edge of the exhaust manifold gasket at the rear of the right cylinder head.

Oil Level Indicator and Tube Installation



1. Inspect the O-ring seal (421) for cuts or damage. If the oil level indicator tube O-ring seal is not cut or damaged, it may be used again.
2. Lubricate the O-ring seal with clean engine oil.
3. Install the O-ring seal onto the oil level indicator tube (420).
4. Install the oil level indicator tube into the engine block and rotate into proper position.

Caution: Refer to Fastener Caution in the Preface section.

5. Install the tube bolt (419) and tighten to **25 N·m (18 lb ft)**.
6. Install the oil level indicator (418) into the tube.

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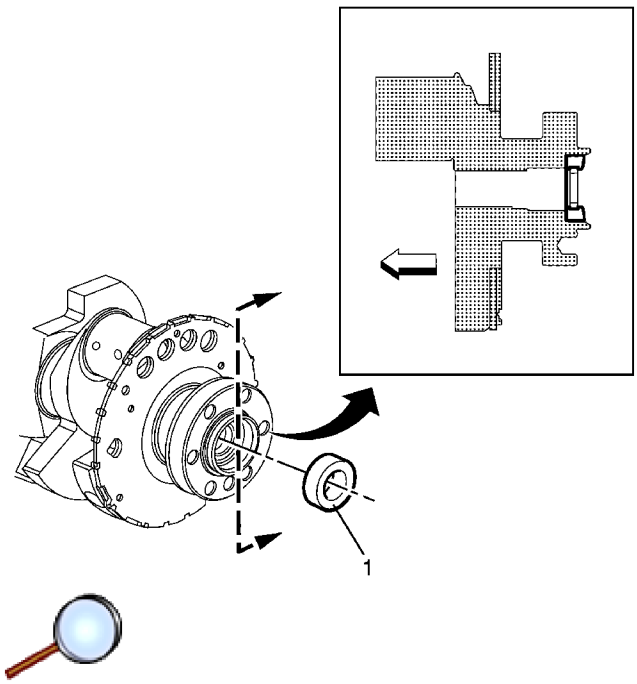
Clutch Pilot Bearing Installation

Tools Required

J 38836 Bushing Installer and Clutch Arbor



Important: Make sure that the crankshaft rear oil gallery plug (1) is not a loose fit, damaged or leaking.

Important: The correct depth (a) for the oil gallery plug is 31.2 to 31.6 mm.

1. Apply sealant LOCTITE R 242 and install it to the correct depth, If replacing the oil gallery plug (1).

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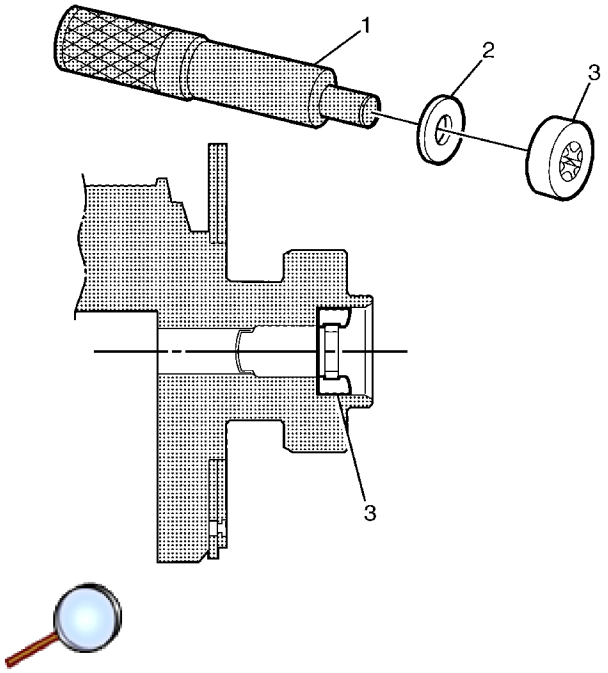
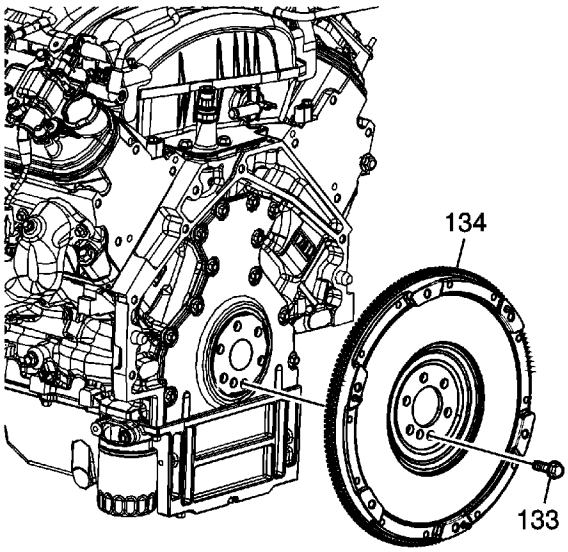


Important: Use a 5/8 inch flat washer (2) against the tool to support the bearing races.

Important: When installed correctly the bearing should be flush with the crankshaft counter-bore.

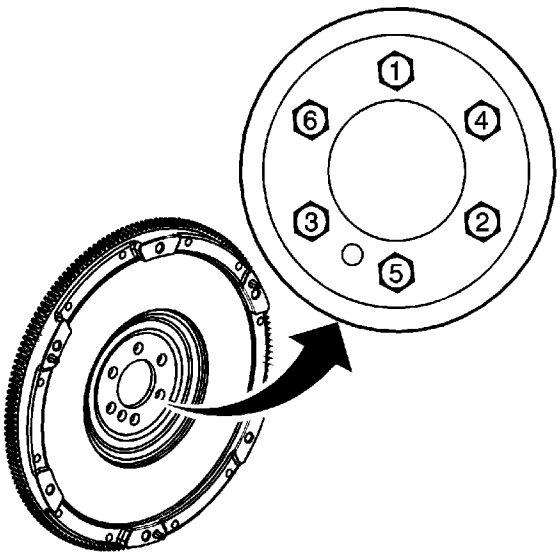
2. Install the clutch pilot bearing (3) to the rear of the crankshaft, using J 38836 (1).

Engine Flywheel Installation



1. Install the flywheel (134) to the crankshaft.
2. Apply threadlock GM P/N 12345382 (Canadian P/N 10953489), or equivalent, to the threads of the flywheel bolts (133).

Caution: Refer to Fastener Caution in the Preface section.



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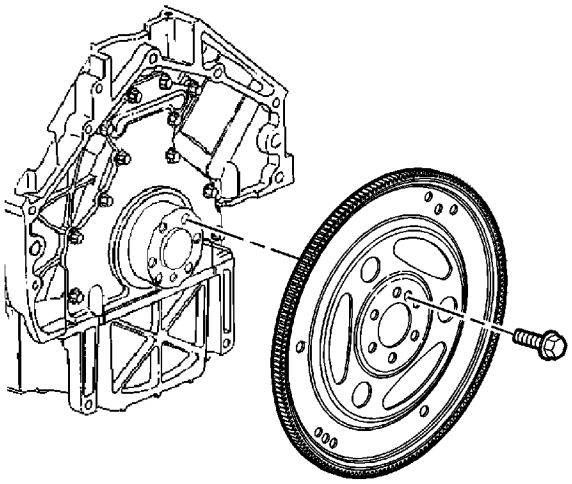
3. Install the bolts.
   3.1. Tighten the bolts (1-6) a first pass in sequence to **20 N·m (15 lb ft)**.
   3.2. Tighten the bolts (1-6) a second pass in sequence to **50 N·m (37 lb ft)**.
   3.3. Tighten the bolts (1-6) a final pass in sequence to **100 N·m (74 lb ft)**.

Automatic Transmission Flex Plate Installation



Note: The flex plate does not use a locating pin for alignment and will not initially seat against the crankshaft flange, but will be pulled onto the crankshaft by the engine flex plate bolts. This procedure requires a 3 stage tightening process.

1. Install the flex plate to the crankshaft.
2. Apply threadlock GM P/N 12345382 (Canadian P/N 10953489), or equivalent, to the threads of the flex plate bolts.

Caution: Refer to Fastener Caution in the Preface section.

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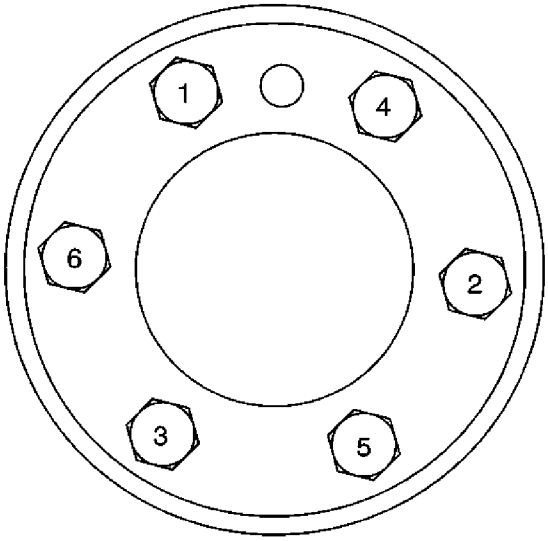


3. Install the engine flex plate bolts.
   3.1. Tighten the engine flex plate bolts (1-6) a first pass in sequence to **20 N·m (15 lb ft)**.
   3.2. Tighten the engine flex plate bolts (1-6) a second pass in sequence to **50 N·m (37 lb ft)**.
   3.3. Tighten the engine flex plate bolts (1-6) a final pass in sequence to **100 N·m (74 lb ft)**.

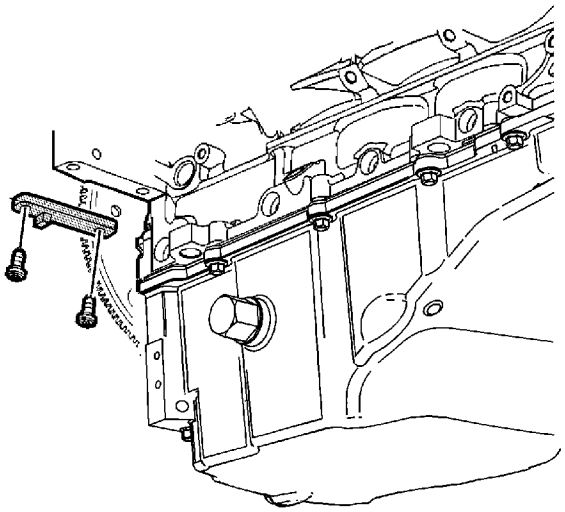
Crankshaft Balancer Installation (L76)

Special Tools

- *J 41478* Crankshaft Front Oil Seal Installer
- *J 41665* Crankshaft Balancer and Sprocket Installer
- *J 42386-A* Flywheel Holding Tool
- *J 45059* Angle Meter

For equivalent regional tools, refer to Special Tools.

Caution: Refer to Fastener Caution in the Preface section.



Note: The used crankshaft balancer bolt is used only during the installation procedure. Install a NEW crankshaft balancer bolt during final assembly.

1. Install the *J 42386-A* holding tool and bolts.

   Use 1 M10 - 1.5 x 120 mm and 1 M10 - 1.5 x 45 mm bolt for proper tool operation. Tighten the *J 42386-A* holding tool bolts to **50 N·m (37 lb ft)**.

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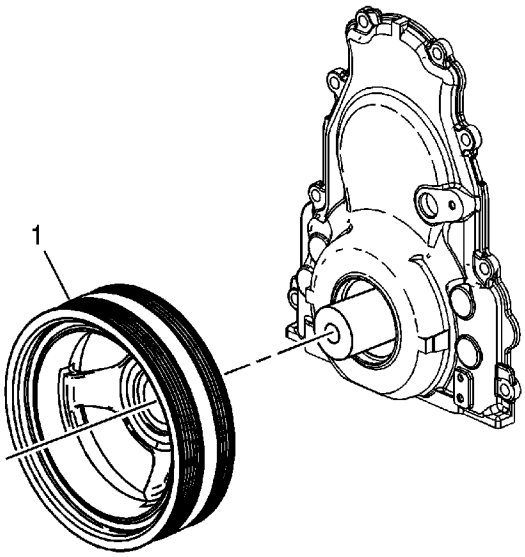
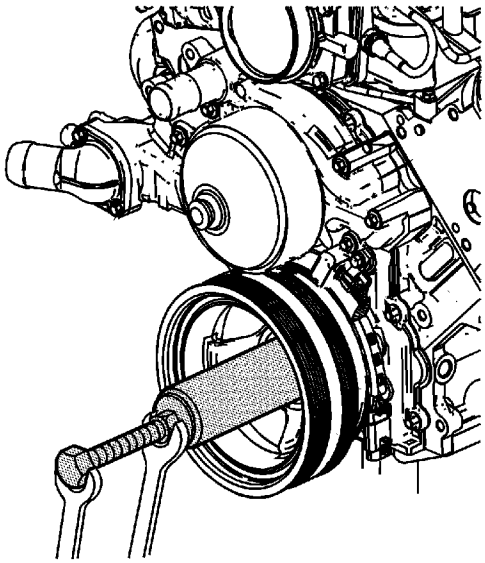


Note: The balancer should be positioned onto the end of the crankshaft as straight as possible prior to tool installation.

2. Position the balancer (1) onto the end of the crankshaft.



3. Use the *J 41665* installer and the *J 41478* seal installer in order to install the balancer.
   3.1. Assemble the *J 41478* seal installer threaded rod, nut, washer and the *J 41665* installer .

   Insert the smaller end of the installer into the front of the balancer.

   3.2. Use a wrench and hold the hex end of the threaded rod.

3.3. Use a second wrench and rotate the installation tool nut clockwise until the balancer is started onto the crankshaft.

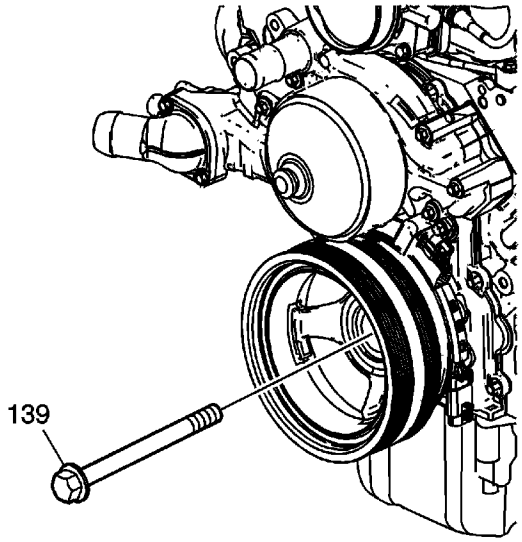
3.4. Remove and reverse the installation tool.

Position the larger end of the installer against the front of the balancer.

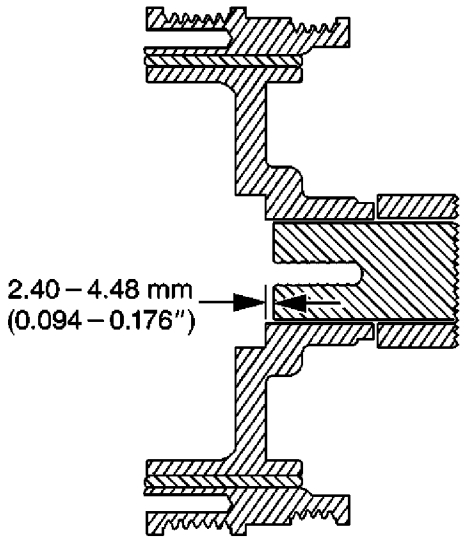
3.5. Use a wrench and hold the hex end of the threaded rod.

3.6. Use a second wrench and rotate the installation tool nut clockwise until the balancer is installed onto the crankshaft.

3.7. Remove the balancer installation tools.



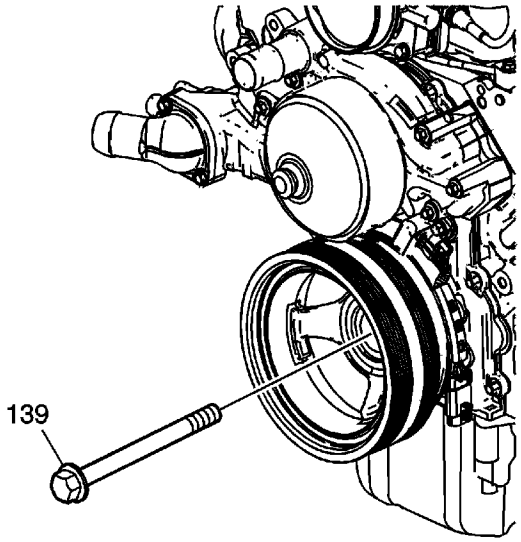
4. Install the used crankshaft balancer bolt (139) and tighten to **330 N·m (240 lb ft)**.
5. Remove the used crankshaft balancer bolt.



Note: The nose of the crankshaft should be recessed **2.4-4.48 mm (0.094-0.176 in)** into the balancer bore.

6. Measure for a correctly installed balancer.

   If the balancer is not installed to the proper dimensions, install the *J 41665* installer and repeat the installation procedure.



7. Install the NEW crankshaft balancer bolt.
   7.1. Tighten the crankshaft balancer bolt a first pass to **150 N·m (110 lb ft)**.
   7.2. Loosen the crankshaft balancer bolt a second pass **360 degrees**.
   7.3. Tighten the crankshaft balancer bolt a third pass to **50 N·m (37 lb ft)**.
   7.4. Tighten the crankshaft balancer bolt a final pass to **230 degrees** using the *J 45059* meter .
8. Remove the *J 42386-A* holding tool .

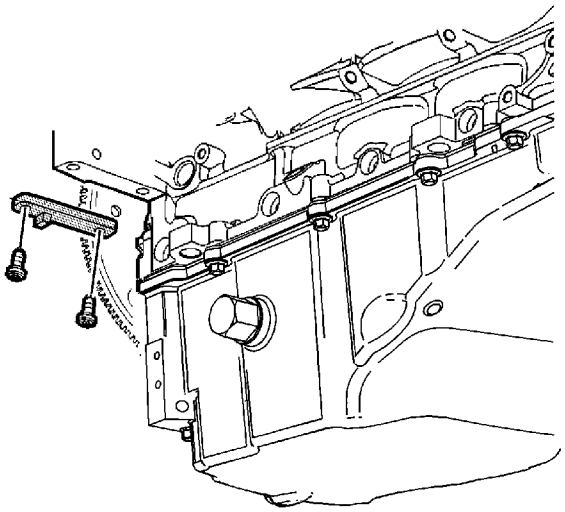
Crankshaft Balancer Installation (6.2L LS3)

Special Tools

- *J 41478* Crankshaft Front Oil Seal Installer
- *J 41665* Crankshaft Balancer and Sprocket Installer
- *J 42386-A* Flywheel Holding Tool
- *J 45059* Angle Meter

For equivalent regional tools, refer to Special Tools.

Caution: Refer to Fastener Caution in the Preface section.



Note: The used crankshaft balancer bolt is used only during the installation procedure. Install a NEW crankshaft balancer bolt during final assembly.

1. Install the *J 42386-A* holding tool and bolts.

   Use 1 M10 - 1.5 x 120 mm and 1 M10 - 1.5 x 45 mm bolt for proper tool operation. Tighten the *J 42386-A* holding tool bolts to **50 N·m (37 lb ft)**.

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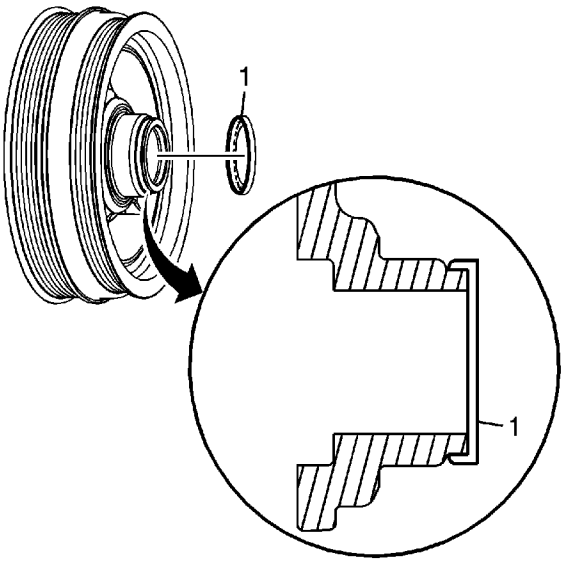
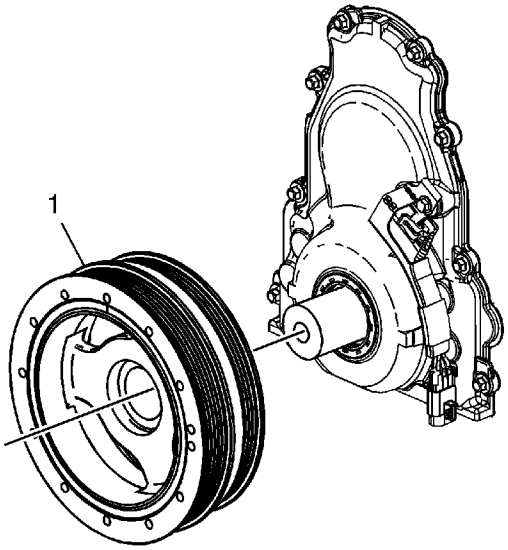
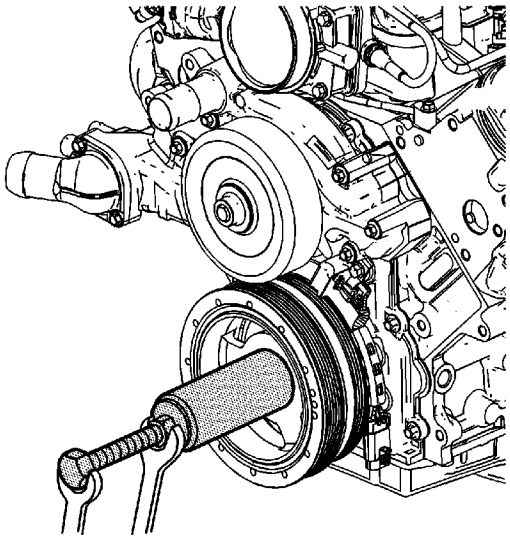


2. Install the crankshaft balancer washer (1) onto the crankshaft balancer.



Note: The balancer should be positioned onto the end of the crankshaft as straight as possible prior to tool installation.

3. Position the balancer (1) onto the end of the crankshaft.



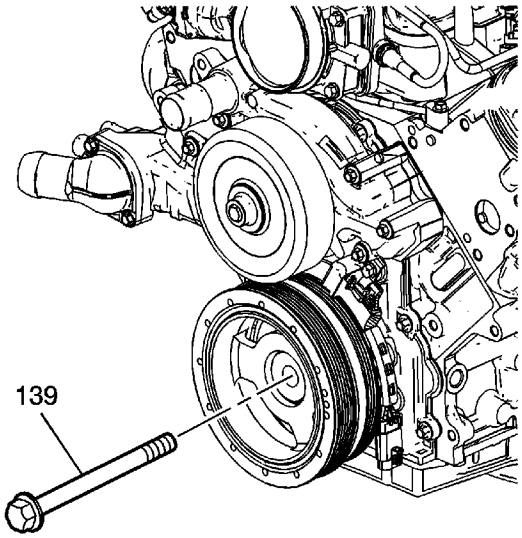
4. Use the *J 41665* installer and the *J 41478* seal installer in order to install the balancer.
   4.1. Assemble the *J 41478* seal installer threaded rod, nut, washer, and the *J 41665* installer .

   Insert the smaller end of the installer into the front of the balancer.

   4.2. Use a wrench and hold the hex end of the threaded rod.
   4.3. Use a second wrench and rotate the installation tool nut clockwise until the balancer is started onto the crankshaft.
   4.4. Remove the tool and reverse the installation tool.

   Position the larger end of the installer against the front of the balancer.

   4.5. Use a wrench and hold the hex end of the threaded rod.
   4.6. Use a second wrench and rotate the installation tool nut clockwise until the balancer is installed onto the crankshaft.
   4.7. Remove the balancer installation tools.



5. Install the NEW crankshaft balancer bolt (139).
   5.1. Tighten the crankshaft balancer bolt a first pass to **150 N·m (110 lb ft)**.
   5.2. Loosen the crankshaft balancer bolt a second pass **360 degrees**.
   5.3. Tighten the crankshaft balancer bolt a third pass to **50 N·m (37 lb ft)**.
   5.4. Tighten the crankshaft balancer bolt a final pass to **230 degrees** using the *J 45059* meter .
6. Remove the *J 42386-A* holding tool .